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THE PROGRESS OF DISCOVERY IN NATURAL PHILOSOPHY, CHEMISTRY, NATURAL HISTORY, PRACTICAL MECHANICS, GEOGRAPHY, NAVIGATION, STATISTICS, AND THE FINE AND USEFUL ARTS,

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THE EDINBURGH PHILOSOPHICAL JOURNAL.

ART. I.—*Account of the Recent Chemical Researches of M.* BERZELIUS *and his Pupils.* In a Letter to Dr BREWSTER from a Correspondent in Stockholm. Continued from Vol. IV. p. 22.)

1 *Experiments of M. Berzelius upon the Alkaline Sulphurets, and on the Combinations of Alkalies with Metallic Sulphurets.*

M. BERZELIUS has communicated to the Academy of Sciences of Stockholm, a Memoir on the Alkaline Sulphurets, in which he has endeavoured to develope the nature of these substances, of which we owe the first detailed account to the labours of M. Berthollet. (*Annales de Chimie*, tom. xxv.) Having discovered the presence of sulphuric acid in Hepar, M. Berthollet attributed its formation to the decomposition of water, the hydrogen of which combining with another part of the sulphur, gave rise to the sulphuretted hydrogen. M. Vauquelin, who has more recently examined these combinations, concludes from his experiments that it was probable, but not proved, that the sulphuric acid is already formed before the addition of water, and that the Hepar is a mixture of sulphate of potash, and of sulphuret of potassium. In this case the sulphur acidifies itself at the expence of the potash. As the experiments of M. Vauquelin leave this question undecided, M. Gay Lussac adduced new proofs in favour of the opinion of that chemist. He observed, that when potash or alcohol is treated with sulphur, at a temperature scarcely so great as red heat, it forms the hyposulphite of potash, and not a sulphate; and by considering the hyposulphite as formed before the addition of water, the sulphate ought to be so also. M. Berzelius observes, that this phenomenon does not decide the question; for at first, the potash or alcohol is, in reality, a hydrate ofpotash; the hyposulphite may form itself at the expence of the water, which ought to be replaced by the hyposulphurous acid; and, besides, it appears, that at a lower temperature the alkalies ought to unite to a maximum of sulphur; whence it follows, that the combinations which sulphur forms with oxygen as well as hydrogen, ought to be in their maximum of sulphuration. M. Berzelius has, therefore, sought more decisive proofs. He made a current of dry hydrogen gas pass over sulphite of potash reddened in the fire, and collected the water which is formed by the reduction of the sulphate The weight of this water indicates, that the potash was decomposed conjointly with the sulphuric acid; and he obtains a sulphuret of potassium of a fine cinnabar red colour. By substituting sulphuretted hydrogen gas, or the vapours of the sulphuret of carbon in place of hydrogen gas, the sulphate of potash is decomposed still more easily, and gives sulphurets more rich in sulphur. All these sulphurets dissolve in water, and their solutions are not disturbed by the muriate of barytes,—a decisive proof, that the water contributes nothing to the formation of the sulphuric acid, and, consequently, that M. Vauquelin's idea, that this acid is formed by the reduction of a certain quantity of potash is perfectly correct. M. Berzelius has proved by experiment, that, on this occasion, three-fourths of the potash are reduced to form the sulphuric acid, which combines with the one-fourth which is not decomposed. *The ordinary Hepar may then be considered as a mixture of* ONE ATOM of sulphate of potash, *with* THREE ATOMS of *sulphuret of potassium.*

M. Berzelius next examines the different proportions in which the sulphur and the potassium may unite; and he finds that there are seven different degrees. The sulphurets of potassium are obtained in the following manner.

1. *The Protosulphuret of Potassium* KS^2, composed of *one* atom of potassium and *two* atoms of sulphur, by the reduction of sulphate of potash by means of carbon or hydrogen. M. Berzelius shews, that this sulphuret has not the combustibility which has been

supposed, and that it is not this sulphuret of potassium only, which renders the pyrophorus of Homberg so extremely combustible.

2. KS^4, (M. Berzelius found, that it would be too much to make a nomenclature for these different sulphurets,) is obtained when sulphur is exposed, with an excess of carbonate of potash, to incandescence in vessels closed against the entrance of air.

3. KS^6, When the mixture of sulphur with carbonate of potash in excess is exposed to a red cherry heat, till it disengages carbonic acid, or when carbonate of potash is decomposed by fire, by means of a current of the vapours of sulphuret of carbon.

4. KS^7. When the sulphate of potash is reduced by means of sulphuretted hydrogen gas, the sulphur is remarkable for its transparency, and by its wine-red colour, bordering a little upon yellow. A part of the sulphur of the sulphuretted hydrogen is set at liberty during the operation, and is deposited with the water in the cold part of the apparatus.

5. KS^8, By the reduction of the sulphate of potash by means of the vapours of sulphuret of carbon; or when sulphuretted hydrogen gas is passed over the ordinary *hepar*, till the sulphate of potash which it contains is decomposed.

6. KS^9, When sulphur is added in excess to the preceding, and the mixture is heated in a current of sulphuretted hydrogen till it yields no more sulphur.

7. KS^{10}, Is the saturated combination of sulphur which constitutes the ordinary *hepar*, when it is prepared by adding to it sulphur in excess.

With respect to KS^7, KS^9, M. Berzelius has doubts of their existence, not because the result of the experiment which yields them is doubtful, but because these *odd* numbers are not yet known in any other inorganic combinations. They may, besides, be very likely nothing more than fixed and determinate combinations of two other sulphurets of potassium; for this evidently takes place with the sulphuret of magnetic iron, whether native or produced artificially. In this last substance the iron is, according to the experiments of Stromeyer, combined with 1⅙th, as much sulphur as in the true protosulphuret of iron, and, consequently, is as 7. to 6.

M. Berzelius thinks also, that the maximum of sulphuration of potassium is not well determined, and that KS^{10} may, probably, be the true protosulphuret; but the experiments which he has yet made on this point only give vague results. He has often, for example, produced a *hepar* of a more lively colour than the ordinary kind, and which dissolves in water, leaving a residue of sulphur in powder. But when M. Berzelius melted the hepar with a great excess of sulphur at a gentle heat, and left it afterwards to cool so slowly, that the sulphur could separate from the hepar by means of its inferior specific gravity, the superior stratum was only pure sulphur, and the inferior one dissolved in water without a residue. A solution of KS^{10} in water, which was made to boil with sulphur, dissolved a little of it; but the sulphur precipitates itself by cooling. A solution of KS^{10} in alcohol, dissolves by digestion much of the sulphur, a part of which separates in cooling; but it is difficult from this, to distinguish between a solution of sulphur in alcohol, and an affinity of potassium for a new dose of sulphur, aided by the presence of alcohol.

M. Berzelius is of opinion, that in every case we may consider the sulphurets of potassium which contain 2, 4, 6, 8 and 10 atoms of sulphur, as well established. It is evident, that the sulphur is found in the very simple ratio of 1, 2, 3, 4 and 5.

M. Berzelius next examines the preparation of hepar in the humid way. Having melted the hydrate of potash with a gentle heat, he added to it small portions of sulphur, which dissolved with strong effervescence, and produced a flocculent matter which swam upon the melted sulphur. The effervescence arose from the disengagement of the vapours of water. The flocculent matter separated from the sulphuret, was the hyposulphite of potash. When the potash employed was in excess, the sulphuret assumed in cooling, the reddish pale colour of cinnabar. This is the colour of the protosulphuret of potassium; and this experiment proves, that it is the potash, and not the water, which was decomposed by the sulphur; for had it been otherwise, it would have formed a colourless hydro-sulphate of potash. Whatever excess we take of potash, it does not form at this temperature either the sulphurous or the sulphuric acid.

When the hepar is prepared in a solution, there is only a single degree which can be observed between the maximum and minimum; and it is this which forms, when a hydro-sulphate of potash is exposed for a sufficiently long time, till its hydrogen is oxidated. It is, therefore, KS^4. The hepar, which is formed by a complete saturation of a lixivium of caustic potash, which is boiled with sulphur, contains three-fourths of potash, converted into KS^{10}, or into a sulphuretted hydro-sulphuret of potash corresponding to it, and one-fourth of potash combined with a quantity of hypo-sulphurous acid, which contains three times as much oxygen as itself*. When potash is added to it, the state of neutrality of the hypo-sulphite changes first, and afterwards, by new additions, that of the sulphuretted hydro-sulphuret.

Among the sulphurets of other alkaline bases, M. Berzelius has examined only those of Calcium. The protosulphuret of this metal is formed, by passing a current of sulphuretted hydrogen gas over pure lime in a porcelain tube, in a state of incandescence. It forms water and sulphuret of calcium, of a light rose colour. It contains no trace of sulphuric acid. The sulphuret is not altered by pure water even when boiling. M. Berzelius has preserved it under water in flasks, full and well corked, during whole months without suffering any alteration. A small portion of this sulphuret is soluble in water. This solution, when evaporated *in vacuo*, yields a white crystalline mass, which, when heated, with the exclusion of air, yields its water of crystallization, and becomes sulphuret of calcium. This sulphuret has then a great analogy with the cyanurets, and the sulpho-cyanurets of alkaline radicals which appear soluble in water; whence M. Berzelius concludes, that this may probably be the case with the sulphurets of the same radicals. The protosulphuret is the only sulphuret of calcium which can be obtained in the dry way. In the humid way we can obtain two others of them, one of which is CaS^4, examined a long time ago by Bucholz and Bernhardi, and more recently by Mr Herschel; and the other, the persulphuret CaS^{10}, which is obtained pure by digesting the protosulphuret with water and sulphur in excess.

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* Nearly $KS^5 + 3KS^{10}$.

The nature of the solutions of the sulphurets may be explained in two ways. They either form hydro-sulphurets of oxidated bases, or, as has already been said, the sulphurets may dissolve without alteration. This question cannot yet be resolved; and the phenomena are equally explicable upon both hypotheses. But in the case of the sulphurets oxidating when they dissolve, it follows, that hydrogen ought to form with sulphur as many acid combinations as there are degrees of sulphuration of potassium soluble in water; that is, we ought to have at least five hydro-sulphuric acids, whose combinations with salifiable bases it would be difficult to distinguish by any nomenclature at once scientific and harmonious. It is true, that these sulphurets of hydrogen cannot be all obtained in an insulated state; but this proves nothing either one way or another. For M. Berzelius observes, that the hypo-sulphurous acid cannot be obtained in an insulated state; and yet the hypo-sulphites are not less real; on the other hand, sulphuretted hydrocyanic acid exists in an insulated state, though it decomposes in contact with potash.

The sulphuret of potassium has a very great tendency to form double sulphurets with a number of substances, particularly electro-negative ones. It is owing to this tendency that the alkaline sulphurets exercise such a dissolving power over a great number of metallic substances; for from KS^4 to KS^{10} the metals appropriate at a high temperature the excess of sulphur, and reduce the different sulphurets of potassium to the state of proto-sulphuret.

The proto-sulphuret of potassium combines with the sulphuret of hydrogen in the proportion of one atom of the former to two of the latter $= KS^2 + 2\,H^2\,S$. This double sulphuret is obtained by passing a current of sulphuretted hydrogen gas over the carbonate of potash, at a cherry-red heat, till the gas which issues from the apparatus contains water and carbonic acid gas. It is slightly yellow, and very crystalline, having the appearance of a melted salt. Dissolved in water, it forms what is called the *neutral hydrosulphate* of potash, (considering the solution of the protosulphuret of potassium as a sub-hydro-sulphate). Sulphur, as well as all the metallic sulphurets, soluble in caustic potash, drive away from it the sulphuretted hydrogen, and combine with the sulphuret of potassium. Three atoms of sulphur and three atoms of the metallic sulphurets in general are required to separate entirely the two atoms of sulphuretted hydrogen, together with one atom of proto-sulphuret of potassium. These decompositions are made even in the humid way. The sulphuret of arsenic (*Orpiment*) pulverised, drives off at an ordinary temperature the sulphuretted hydrogen gas from a solution of neutral and slightly concentrated hydrosulphate of potash, with the same force as if a liquid acid had been added to it.

The proto-sulphuret of potassium combines equally with two atoms of the sulphuret of carbon $= KS^2 + 2\ CS^2$; but when this combination is prepared in the dry way, it decomposes when dissolved in water; the carbon separates from it entirely, and the solution contains only KS^6. The proto-sulphuret of potassium dissolves the sulphuret of carbon in the humid way without separating from it the carbon.

Besides these two double sulphurets, M. Berzelius has examined the action of the alkalis and their sulphurets on the sulphurets of Arsenic, Molybdena, Chrome, Tungsten, Titanium, Tantalium, Antimony, Gold, Platina and Rhodium. There are four methods of dissolving the metallic sulphurets in an alkaline menstruum. 1. To dissolve the metallic sulphuret in a solution of the protosulphuret of potassium, or of the double sulphuret of potassium and hydrogen, (hydrosulphate of potash). 2 To dissolve the oxide of the metal by the double sulphuret of hydrogen and potassium. 3. To dissolve the metallic sulphuret by caustic potash; and, 4. To melt together the metallic sulphuret and the carbonate of potash, and afterwards to dissolve the melted mass in water. The general result of all these ways of dissolution is, that it forms a combination of sulphuret of potassium with the other metallic sulphuret, which is added. In the first method, this combination is made directly, or when we employ the hydrosulphate, the sulphuretted hydrogen is disengaged by the other sulphuret, which replaces it, in the sulphuret of potassium. In the second, the sulphuretted hydrogen reduces the metallic oxide to the state of sulphuret, and the sulphuret thus produced combines with the sulphuret of potassium. In the third, a part of the metal is oxidated at the expence of the potash, (or the water,) and the metallic oxide combines with a portion of the potash. The potassium (or the hydrogen) reduced unites with the sulphur, abandoned by the oxidated part of the metal, and the sulphuret of potassium thus produced, combines with the undecomposed metallic sulphuret. When an acid is poured into it, the potassium is reoxidated at the expence of the metallic oxide, to which it restores the sulphur, and the metallic sulphuret is wholly precipitated as if it had been dissolved without decomposition. The fourth method gives the same result as the third, with this difference only, that the metal is commonly brought to a higher degree of oxidation, from which there arise some slight modifications of the phenomena We may also add to these a fifth method, that is, when a metallic sulphuret is dissolved in a solution of carbonate of potash, or of soda. The carbonates, however, dissolve only a little of the metallic sulphurets, they are not decomposed, and the solution appears to be made like that of a salt in water. Of all these metallic sulphurets, that of antimony presents the most important results, both from the apparent exception which they make to rules, and from the use which has so long been made of the preparations of this sulphuret. Water separates the greatest part of the sulphuret of antimony from its combination with the sulphuret of potassium, exactly as it does the same from combinations of the oxide of antimony with acids. Warm water, however, separates less of it than cold water. The *Kermes* mineral is nothing else than sulphuret of antimony separated in the humid way from the sulphuret of potassium, either by the cooling of the liquid, or by the addition of water to a concentrated solution. The *sulphur auratum* of druggists is a sulphuret of antimony proportional to the antimonious acid. The production of this sulphuret, as well as of the sulphuretted hydrogen gas, when we pour an acid into the liquid from which the Kermes has been precipitated, arises from a great complication in the action of the potash upon the sulphuret of antimony It forms two combinations, one of oxide of antimony and potash, and the other of oxide of antimony and sulphuret of antimony, *(Crocus antimonii,)* which remain undissolved when water is added. The warm liquid oxidates quickly at the expence of the air, and the sulphuret of potassium, deprived already by the water of a part of its sulphuret of antimony, is decomposed, so that it forms potash and a sulphuret of potassium with more sulphur. When an acid is poured into it, this last converts the potassium into potash. The excess of sulphur in this last substance combines with the antimony, and the potassium, which can no longer oxidate itself at the expence of the oxide of antimony which remains undissolved, decomposes the water, and gives birth to the sulphuretted hydrogen. The quantity of *sulphur auratum* is greater, when the Kermes is prepared by the fusion of sulphuret of antimony with carbonate of potash; for, on this occasion, it is formed of the antimonite of potash, and a part of the antimony is reduced to the metallic state.

2. *Account of M. Berzelius's recent Experiments on the Composition of the Oxides of Platinum and Gold.*

a. *Oxides of Platinum.*

Dr Thomson, who has undertaken to correct analyses which have been made with the utmost care by other chemists, and who assures us, not without ostentation, that he has found the true results, at the same time that he commits serious mistakes whenever he does not follow in the track of a skilful predecessor, has, in the fifth edition of his System of Chemistry, (vol. i. p. 501.) rejected the analyses of the oxides of platinum made by M. Berzelius, and substituted in place of them the analyses of a pretended prot-oxide by Mr Cooper. M. Berzelius having discovered the proto-muriate or proto-chloride of platinum, he decomposed it by heat, and determined the quantity of metallic platinum which remained. The proto-muriate is decomposed by the caustic alkalis, which take up the muriatic acid, and leave a black oxide, soluble in alkalis and acids, with a greenish or rather black colour. M. Berzelius deduces in an incontrovertible manner the composition of this oxide from that of the proto-muriate. He afterwards decomposed the ordinary muriate of platinum with metallic mercury, and found that the metal was combined in it with two times as much oxygen as in the prot-oxide. Mr Cooper, who found these methods "*objectionable*," precipitates a solution of muriate of platinum with nitrate of mercury, and heats the precipitate thus obtained at a temperature necessary to sublime the calomel, which forms nearly four-fifths of it. The black powder which remains, Mr Cooper declares to be the true prot-oxide, which contains $4\frac{3}{4}$th hundreds of its weight of oxigen; and what is very remarkable, which dissolves in the muriatic acid, and gives the same muriate as is found in the nitro-muriatic solution of platinum *. Dr Thomson adopts the accuracy of the results of Mr Cooper, and with regard to the per-oxide, he reasons in the following manner: " Mr E. Davy, says he, has found, that 100 parts of potassium combine with 11.86 of oxygen; and M. Berzelius has found that 16.494 parts of oxigen combine with this same quantity of the metal. The mean of these two analyses is 14.177, which is not very remote from 13.269, which would be the quantity of oxigen necessary, in order that the oxygen of the per-oxide should be three times that of the prot-oxide." From this Dr Thomson sagaciously concludes, that the per-oxide of platinum is a trit-oxide.

M. Berzelius has shewn, that the precipitate obtained by Mr Cooper is a mixture, or perhaps also a combination of per-oxide of platinum with the proto-muriate of mercury, from which the muriatic acid may extract the per-oxide. By the heat necessary for the sublimation of the proto-muriate of mercury, the oxide of platinum is decomposed, and the progress of this decomposition ought to vary both with the temperature employed for the sublimation of the calomel, and with the time during which the oxide is exposed to this high temperature. M. Berzelius has made a new analysis of the per-oxide of platinum, which coincides perfectly with the numbers which he has given in his Chemical Tables. He placed the double muriate of platinum and potash in a small ball, blown in the middle of a piece of barometer tube, and he afterwards passed a current of dry hydrogen gas along the tube, heating the ball slightly with a lamp. The salt, which does not contain water, was decomposed; the hydrogen gas was converted into muriatic acid gas, and when the muriatic acid was driven off in this way, he weighed the residue, which contained muriate of potash and metallic platinum. The loss was due to the oxy-muriatic gas or the chlorine of modern chemists. The muriate of potash was sepa-

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* *Journal of the Royal Institution*, Vol. iii. No. v. p. 122.

rated from the metal by water, and the platinum weighed. A hundred parts of this double salt gave

Oxymuriatic gas, or chlorine,	29.2
Platinum,	40.0
Muriate of potash,	30.8
	100.0

The muriatic acid, abandoned by the oxide of platinum, makes twice the quantity of the same acid in the muriate of potash remaining; consequently the double salt is composed of one atom of muriate of potash, and two atoms of the permuriate of platinum, or, if we prefer it, of one atom of the chloride of potassium, and two atoms of the perchlorure of platinum. In calculating from the Tables of M. Berzelius, the quantity of platinum in this salt, we shall find it to be 40.066.

M. Berzelius has also analysed the double muriate of platinum and soda, and has found it to be composed of one atom of muriate of soda, two atoms of the permuriate of platinum, and twelve atoms of water, that is to say, it contains of platinum 19.25 hundredths of its weight.

b. *Oxide of Gold.*

M. Pelletier, in his interesting memoir on the chemical nature of the oxide of gold, has examined the properties and the composition of the ioduret of gold, and concludes from this last, that the atom of gold should weigh 29.93, instead of 24.86, as follows from the experiments of M. Berzelius. In a new investigation, for the purpose of examining the assertion of M. Pelletier, M. Berzelius decomposed the neutral muriate of gold, by carbonate of soda in excess. Having evaporated the mass to dryness, it was brought to a red heat, and being re-dissolved by water left metallic gold. The solution was neutralised by the nitric acid, and precipitated by the nitrate of silver. In this manner M. Berzelius found the weight of gold to be a little lighter than formerly, but he attributed this to the great tendency of the muriate of gold to form a supermuriate, by the successive reduction of the oxide of gold dissolved. On this occasion he shews, that the oxide of gold forms with the muriatic acid two combinations, one of which is a deep red, even when dissolved in water, and is the neutral muriate; the other, which is yellow, and easily crystallised, is the supermuriate. The observation of M. Pelletier, that the muriate of gold is reduced by the oxalates, induced M. Berzelius to examine, if, on this occasion, the quantity of gold reduced corresponded to the composition of the oxalic acid, which he had deduced from his analyses, that is, if this acid contains the small quantity of 0.0025 of hydrogen, which he believed he had found in it. A hundred parts of anhydrous oxalate of lime reduced 103.13 of gold to the metallic state, and 100 parts of the quadroxalate of potash, (which contains 24.8 *per cent.*, or 14 atoms of water) reduced 102.5 parts of gold. If the acid does not contain hydrogen, the calculation gives, in the first of these experiments, 103.58, and in the last 104. The experiments then prove, 1*st*, That the oxalic acid is composed of one atom of carbon, and three atoms of oxygen, without hydrogen; for, on the supposition that it contained 0.0025 of hydrogen, it would have reduced no less than $\frac{1}{13}$th more of the gold; and, 2*dly*, That the weight of the atom of gold, determined by the former analysis of M. Berzelius, approaches as near the truth, as can be done by our present analytical means.

3. *Researches on the Composition of some Mineral Substances, by* M. A. Arfwedson.

M. Arfwedson has recently discovered a new method of preparing Lithion. It consists in exposing an intimate mixture of Triphane, or Spodumene, in a fine powder, with quick lime, in a Hessian crucible, to a very strong heat. The burnt mass is dissolved by the muriatic acid, and the solution evaporated to dryness, in order to separate the silica. Sulphuric acid is afterwards added, and the mass is heated till the greater part of the muriatic acid is driven off. The residue is next diluted with water, and the liquid is separated from the gypsum by strong expression. The acid liquid then obtained is digested with the carbonate of lime in water, in order to precipitate the alumine. It is then filtered and evaporated. The crystals of the sulphate of lithion are then easily separated from those of the sulphate of lime. If we wish to prepare the carbonate of lithion, we must decompose the sulphate by means of the acetate of barytes, or of lead, and afterwards decompose the acetate of lithion by heat.

M. Arfwedson has also verified the assertion of M. Gmelin, of Tubingen, that there does not exist an Alum with a base of lithion and alumine, as he had at first believed. He finds that the error was owing to the presence of potash in the alumine, even in that which he had completely edulcorated. The sulphate of lithion contains two atoms of water, that is 14.27 hundredths.

M. Arfwedson has analysed the following minerals :

a. The *Disthene*, or *Cyanite* of St Gothard and of Norway.

	Disthene of St Gothard.	of Norway.	Theory.
Silex, -	34.33	36.4	32.00
Alumine,	64.89	63.8	68.00
	99.22	100.2	100.0

Hence he concludes that the disthene is a subsilicate of alumine, in which the last contains twice as much oxygen as silex A^2S. The difference between the theory and the experiment may be owing to a variable mixture of a silicate of alumine with the subsilicate.

b. The *Nepheline of Somma.* M. Vauquelin found in this mineral only silex and alumine. The following is M. Arfwedson's analysis :

Silex, - - -	44.11
Alumine, - - -	33.73
Soda, - - - -	20.46
Loss in the Fire, - -	0.62
	98.92

This composition gives the formula NS+3AS.

c. The *Sodalite of Vesuvius,* which is known from the analysis of M. Dunin Borkowsky. M. Arfwedson found that this stone contains muriatic acid like that of Greenland, in which it was discovered by M. Ekeberg. M. Arfwedson's analysis is as follows :

Silex, - - - -	35.99
Alumine, - - - -	32.59
Soda, - - - - -	26.55
Muriatic Acid, - - -	5.30
	100.43

M. Arfwedson considers the muriatic acid as essential to the composition of this stone. He thinks it probable that it may contain *one* atom of a double subsilicate of soda and alumine, combined with four atoms of the combination which constitutes Nepheline, that is $(N^2M+2A^2M)+4(NS+3AS)$

4. *Researches respecting the Pyroxenes*, &c. by M. Henry Rose.

We have already communicated to you (See this Journal, vol. iv. p. 21.) the general result of the great work of M. Rose on the pyroxenes, viz. that these stones are bi-silicates, sometimes double, and sometimes only mixed with four bases, viz. lime, magnesia, the protoxide of iron, and the protoxide of manganese. We shall now give you the numerical results of all M. Rose's analyses, from which you will see that in every case the silex contains twice as much oxygen as the bases together.

Analyses of the Pyroxenes or Malacolites.

Localities of the Minerals.	Orrjasri, in Finland.	Sala, in Sweden.	Bjornmyresveden.	Ditto, another Variety.	Taberg, in Wermeland,	Tunaberg, (the *Hedenbergite*,)	Langbanohyttaw.	Do. do. Oxyde de Manganese Silicifere, H.	Degero, in Finland.	Tjotten, in Norway,
Authors of the Analyses.	Rose.	Rose.	Rose.	Rose.	Rose.	Rose.	Rose.	Berzelius.	Berzelius.	Count Wachtmeister.
Silex, -	54.64	54.86	54.55	54.08	53.36	49.01	55.32	48.00	50.0	57.11
Lime, -	24.94	23.57	20.21	23.47	22.19	20.87	23.01	3.12	20.0	24.94
Magnesia, -	18.00	16.49	15.25	11.49	4.99	2.98	16.99	0.22	4.5	16.7[illegible]
Protoxide of Iron,	1.08	4.44	8.14	10.02	17.38	26.08	2.16	Traces.	19.0	0.20
Protoxide of Manganese,	2.00	0.42	0.73	0.61	0.09	Traces.	1.59	49.04	3.0	—
Alumine, -	0.	0.21	0.14	—	—	—	—	—	0.9	0.436
									Loss in Fire.	
Total, -	100.66	99.99	99.02	99.67	98.01	98.94	99.07	100.38	97.4	99.45

M. Rose has also analysed the *Analcime*. He finds that it contains the same combination as the *Amphigene*, or *Leucite*, with this difference only that it contains soda, whereas the amphigene contains potash; and that the analcime contains two proportions of water, whilst the amphigene is anhydrous. The chemical composition of analcime will then be $NS^2 + AS^2 + 2Aq$. The two minerals affect the same form. M. Rose asks, if the soda, combined with these two proportions of water, may not be isomorphous with the anhydrous potash?

This skilful young chemist has also studied the nature and composition of the *Oxide of Titanium*, which has so long been little known. M. Rose entertained the happy thought of reducing the oxide of titanium to the state of sulphuret, by means of the vapours of the sulphuret of carbon, which he made to pass through an incandescent porcelain tube, containing the oxide of titanium. The sulphuret of titanium thus obtained, is a greyish-yellow mass bordering on green, which, by the slightest touch, takes a metallic lustre resembling the magnetic sulphuretted iron. When this sulphuret is heated with caustic potash, it oxidates, and there results from it a hydrosulphate and a titanate of potash, without excess of sulphur, and, consequently, the sulphuret of this metal contains the same number of atoms of sulphur as there are atoms of oxigen in the oxide. By exposing it to the fire, it burns with a blue flame, and is converted by degrees into an oxide of titanium. The difference between the weight of the sulphuret and that of the oxide, indicates the quantity of oxigen which it contains. The oxide of titanium contains 33 93 hundredths of its weight of oxigen. It does not possess any of the characters of a salifiable base. The nitrate and the muriate of titanium, which chemists have described, are merely salts with a base of potash and soda. The oxide of titanium is precipitated from its solutions in a great part by ebullition. The insoluble combinations which it appears to form with the Sulphuric, Arsenic, Phosphoric, and Oxalic Acids, are not salts. The oxide in them contains at least four times as much oxigen as the acid, and sometimes even more. The oxide of titanium combines with water, and reddens vegetable blues. At a high temperature it drives off the carbonic acid, and combines with the bases. We ought, therefore, to change its name into *Titanic Acid*. The titanates of potash and soda may be obtained by melting the titanic acid with the carbonates of potash, or soda in excess. The titanate is separated from the carbonate by cooling, and forms a crystallised stratum, partly below the melted carbonate. The capacity of saturation of the titanic acid is 16.97; that is, the base contains half as much oxigen as the acid. The neutral titanates are in a great degree decomposed by water, which produces super-titanates, but which M. Rose has never been able to obtain at a fixed degree of combination, probably because the water decomposes them successively. M. Rose has also examined the blue oxide of titanium, but he has not been able to determine its composition.

This chemist has also employed the sulphuret of carbon to obtain several other metals in the state of sulphurets, which have not been known under that form. M. Berzelius suggested to him to examine in that way the *Tantalum*, the composition of which had been determined by M. Berzelius, conjointly with Messrs Gahn and Eggertz, by the reduction of the oxide in a crucible of charcoal. If the metal combines with the charcoal, the result cannot be exact. M. Rose has undertaken this inquiry. The oxide of tantalum gives a greyish sulphuret of tantalum, the combustion of which appeared to indicate that the oxide of tantalum contains a little more oxigen than the reduction with the charcoal had indicated. M. Rose is at this moment occupied in the inquiry.

5. *Researches respecting the Amphiboles, by M. de Bonsdorff.*

M. Bonsdorff has particularly studied those minerals which crystallise in the form of the Amphibole. He found that the pure amphiboles are composed of 1 atom of trisilicate of lime, combined with 3 atoms of bisilicate of magnesia, $= CS^3 + 3MS^2$; and also, that these two bases, the lime and the magnesia, may be mutually replaced, and may also be replaced by other isomorphous bases, particularly the protoxides of iron and manganese. The amphiboles often contain other foreign substances. The fluoric acid is rarely wanting in them, and appears to be combined with lime, of which we then find an excess proportional to the quantity of fluoric acid. A great number phiboles contain also alumine, and as the quantity of that earth increases, that of the silex diminishes; whence M. Bousdorff concludes that the first may, in the quality of an electro-negative, or acid body, replace the last. It appears, from the experiments of M. Bonsdorff, that a *bisilicate* may be replaced, without change of form, by a *trialuminate*, either of the same, or of an isomorphous base. The memoir of M. Bonsdorff, which will be found in those of the Academy of Sciences of Stockholm, contains a number of results of great value in chemical mineralogy, but which cannot be communicated in an extract. The following table contains the numerical results of the analyses:

M. BONSDORFF'S *Analyses of the Amphiboles.*

Constituent Principles.	From Gullfio, in Wermeland. *White.*	From Fahlun. *Whitish-yellow.*	Actinote of Taberg in Wermeland. *Ditto.*	Asbestos of Tarantaise in Savoy. *Black.*	From Aker. *White.*	From Aker. *Deep green.*	From Nordmark. *Black.*	From Vogelsberg in Wetterau. *Brown.*	The Pargasite. *Translucid and Greenish.*	From Pargas. *Black.*
Silex, -	60,31	60.10	59,75	58,20	56,24	47,21	48,83	42,24	46,26	45,69
Magnesia, -	24,23	24,31	21,10	22,10	21,13	21,86	13,61	13,74	19,03	18,79
Lime, -	13.66	12,73	14,25	15,55	12,95	12,73	10,16	12,24	13,96	13,83
Alumine, -	0 ,26	0,42	—	0,14	4,32	13,94	7,48	13,92	11,48	12,18
Protoxide of Iron,	0,15	1,00	3,95	3,08	1,00	2,28	18,75	16,26	3,78	7,32
Protoxide of Manganese,	—	0,47	0,31	0,21	0,26	0,57	1.15	0,33	0,36	0,22
Fluoric Acid,	0,94	0,83	0,76	0,66	0,78	0,90	0,41	—	1,60	1,50
Water, -	0.10	0,15	—	0,14	9.50	0,44	0,50	—	0,61	—
Total, -	99,65	100,01	100.12	100.08	100,18	99,93	100,89	98.77	97,21	99,53

Analysis of Red Silver Ore.—M. Bonsdorff has analysed the red silver ore, which, from the experiments of Vauquelin and Klaproth, was believed to be a combination of sulphuret of silver, sulphuret of antimony, and oxide of antimony. He has proved that this mineral does not contain a trace of oxigen. In order to analyse it, he employed the method quoted above, which M. Berzelius made use of to reduce the muriate of platinum; that is, to pass a current of dry hydrogen gas over the ore heated in a small glass globe. From this is obtained sulphuretted hydrogen gas, without a trace of humidity, and there remains at last a metallic button of silver and antimony deprived of their sulphur. The metals were then separated by cupellation. The mineral contained

Silver,	58,949
Antimony,	22,846
Sulphur,	16,609
Gangue,	0,299
	98,703

The two metals exist in such proportions that they occupy equal quantities of sulphur, that is, $3AqS^2+2SbS^3$.

P. S. M. P. Strom, a Norwegian mineralogist, has analysed and described a new mineral species, from Eger, in Norway. It consists of

Silex,	54,27
Oxide of Iron,	34,44
Soda,	9,74
	98,45

He proposes to call it *Wernerine*, after the celebrated Werner, since what has been called *Wernerite*, is nothing more than Amorphous Paranthine.

M. Mitscherlich has communicated to the Academy of Sciences of Stockholm his important dissertation on the Identity of Form of the Phosphates and Arseniates. This memoir contains, first, a crystallographic exposition, and afterwards a series of experiments, which prove, that the arsenic and phosphoric acids give, with the same bases, analogous combinations, which contain at the same time an equal number of atoms of water. The analogous combinations affect also entirely the same crystalline form. This important fact is an incontrovertible argument against the idea of M. Hauy, that the geometrical form of a combination is the most essential character for determining mineral species; for we cannot consider, for example, the neutral phosphate of any base as the same mineral species with the neutral arseniate of the same base.

STOCKHOLM, }
Aug. 2. 1821. }

ART. II.—*Account of the Earthquake which desolated the Island of Zante, on the 29th December* 1820. In a Letter to M. DE FERUSSAC from COUNT MERCATI *.

SOME days before this frightful event, the atmosphere appeared dreadfully disturbed on every side, and created the most serious alarm. Clouds of the blackest hue, and colours either of the deepest red, or that of burning sulphur, occupied the horizon, and appeared to be in a state of electrical activity. On the 29th of December last, the day of the earthquake, the atmosphere became still more frightful. The wind blew from the SSE. Fahrenheit's thermometer stood at 65°, or the same temperature that we feel in advanced spring weather, and the barometer at 27.4. The clouds appeared to be in groups, and in a perpetual state of agitation. The lightning played without ceasing. The wind began to blow more violently, and, from two o'clock in the morning, it was so strong as to remind us of an American hurricane. Having resolved not to go to bed, I proceeded to examine the atmosphere, and the convulsive motions with which it was agitated. Towards midnight, I heard a dull and broken sound, which seemed to issue from the bosom of the earth. It resembled the noise of a distant drum, beat from time to time in a vault. It was heard by almost every body who was awake at the time. We passed the night in this horrible state; and, at ten minutes before four in the morning, a sudden gust of wind, of most extraordinary violence, made us believe that the end of the world had arrived: and, what completed our surprise, it grew calm in a moment. As if I foresaw the misfortune that threatened us, I felt within me the most melancholy presentiments. My soul was agitated with feelings that I cannot express. I threw myself on my bed, and was absorbed in the sullen and gloomy silence of nature, when all at once I was confounded with the most dreadful subterraneous roaring, which formed the commencement of our terrible catastrophe. The motion of the earth was felt at that instant. I rose immediately; but the violence of the shocks threw me back again on my bed. There were three shocks.

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* Translated from the *Journal de Physique*, Juin 1821, tom. 92. p. 466.

The first was very strong and vertical; the second produced an undulating movement; and the third, which was the most violent, created a rotatory motion. A sudden and confused noise of clamours and cries arose, and announced the general distress of the people, who thought that the last day was come.

The violence of the shocks threw down the strongest built houses: eighty were overturned from the foundation; nearly 800 were dreadfully shattered; and others so much injured as to be uninhabitable till they were repaired *.

In the midst of so many disasters, it is very astonishing that only four persons perished among the ruins, and a few were wounded. The earthquake lasted about thirty seconds, though some people say only fifteen. But the oscillation continued after the shocks; so that, from the beginning to the end, one could count a minute. The people and the English garrison, frightened at this horrible disaster, implored the Divine clemency in the streets.

While the Government and the people followed the procession, called forth by piety and the general terror, another misfortune befel us. All at once, the clouds, which were grouped in whirls, discharged themselves in rain, accompanied with a small kind of hail; then the storm redoubled, and discharged a quantity of hail, of a size so extraordinary, that some of the crystals weighed six ounces, and, as some say, even two pounds. These crystals were irregular polygons, with their angles extremely acute. After the first commotion, we found the other shocks less considerable. The horizon and the wind had not changed during twenty-five successive days. In the night of the 30th, a new hurricane, such as I believe no one ever before experienced, was sent to assail us. Before midnight, the wind rose in the south-east with an incredible violence, and at the same time a deluge of rain and of hail descended. The currents which precipitated themselves, during four hours, down the hills, which rise above the town, quickly carried away with them whole houses, which were swallowed up with all that they contained. These torrents not being able to find a pas-

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* The Gazette of Corfu of the 6th January 1821, makes the number of houses destroyed 300, and those which were much injured 500.

sage along the canals, which were obstructed by the ruins of the houses, overflowed and inundated the whole town, which at day-light presented the most dreadful spectacle; and two unfortunate persons, who had not time to escape from death, were carried away with their houses.

The rain during all this time was overturning on every side the walls of the houses, already shattered in every part, so that from the derangement of the roofs, and the dangerous state of the buildings, we had not a corner in which shelter could be found. The churches were our only asylum, for owing to their particular construction, they were preserved from the general ruin.

It appears that the earthquake, from the direction of the shocks being SE. and NW., had its origin in the sea, and that it was felt at the distance of nearly 250 miles round. On the 6th of January, just nine days after the first, we experienced a second earthquake, which was not preceded by any perceptible bellowing, and it was a very weak one in comparison with the first. It lasted nearly twenty-four seconds. The oscillations, which were widely extended, appeared to have the same direction as those of the first. Its effect was most powerful to the west of the town, and in the rest of the island, where it made great havoc; but though it was weak in comparison with the first, it could not but produce the most distressing effects upon our town, on account of the general ruin occasioned by the former.

I should be deficient in gratitude, were I to pass over in silence the generosity and humanity of Lord Viscount Strangford, Ambassador Extraordinary from his Britannic Majesty to the Ottoman Porte, who was in our port at the time,—of the Resident of the Lord High Commissioner to his Majesty, Sir P. Ross, and of many other English, who assisted the unfortunate during this frightful catastrophe.

I shall proceed now to describe to you a phenomenon which happened previous to the first earthquake.

Three or four minutes before, there was seen at the distance of two miles from the point or promontory of Geraca, which is to the SE. of the island, a kind of meteor, burning, and almost swimming, on the sea, and which continued luminous five or six minutes. At the distance from which it was seen it seemed to be five or six feet in diameter. Could this be hydrogen gas emanating from some volcanic submarine cavern, and which, issuing out of the water in an aeriform column, sought to come in contact with the electricity of the atmosphere? This gas taking fire, continued to burn till the inflammable matter was consumed.

On the day after the first earthquake, at 4 o'clock in the evening, we saw a true meteor, which, describing in the air a vast parabola from east to west, fell into the sea beyond our island. A similar meteor fell at Cephalonia, near the town, and also into the sea, without being accompanied with any explosion. Ever since this great disaster, which has reduced us to the most distressing condition, our atmosphere has appeared in continual agitation. Nature itself seems to have changed its course. We find ourselves suddenly in a different climate. The thermometer which, in the month of January, was at 65° Fahrenheit, stands at present exposed to the north only at 25°. Since the 1st February, the sea has been in a continual storm. From the information which has reached us, this confusion appears to be universal in all the ports of the Mediterranean.

ZANTE, 21*st February* 1821.

ART. III.—*Description of the Trinity Pier of Suspension at Newhaven, near Edinburgh.* By Captain SAMUEL BROWN, R. N. In a Letter to Dr BREWSTER.

DEAR SIR,

IT was my intention to have furnished you with a description of the Union Bridge of Suspension, which I erected over the river Tweed, in the summer of 1820; when I found myself anticipated by Mr Stevenson, civil engineer, who was present at the opening of the bridge on the 26th July 1820. As he has gone into the detail of the dimensions of the iron-work, and the mode of uniting it, with a description of the piers or abutments of the bridge, it is unnecessary for me to enter upon that part of the subject.

Yet there are a variety of essential points which it is necessary for an architect or operative person to be acquainted with, which it could not be expected Mr Stevenson could enlarge upon, and which, in justice to other important subjects, could not be compressed in a periodical work. I consider, indeed, the erection of the Tweed Bridge, and the Pier of Suspension, to be a prelude to many other works of the same kind, all subject to different arrangement, according to their extent and magnitude, the weight they have to support, and every variety of position of which the design is susceptible. I have no doubt that the subject will be regarded of sufficient importance to engage the attention of some of our eminent writers on mechanics.

Without any further allusion to what has before been said of the Union Bridge, I may be permitted to mention the fact, which is paramount to all others,—that ever since it has been opened, it has given entire satisfaction, and has been in constant use without any restriction, in the same manner as any other bridge of stone or cast-iron

The pontage, which is not higher than the road-tolls, has paid in the first year more than the interest of the money which was expended in erecting it, including one thousand pounds which the trustees voted to me in June last above the estimate; and there is every reason to believe, that it will, in a few years, redeem the capital invested.

A new application of the same principle, has just been successfully completed by the erection of the Trinity Pier of Suspension in the Frith of Forth, near Edinburgh, of which a Perspective View, Elevation, and Plan, are given in Plate I. Fig. 1. 2. and 3. This work was undertaken at the expence of the proprietors of the steam vessels employed in the Frith of Forth, and several gentlemen forming the Trinity Pier Company. From the increased intercourse with this part of the coast, by means of steam boats, it became almost indispensable for the proprietors to improve the landing, and as no arrangement could be made with the trustees of the pier at Newhaven, it was proposed by Lieut. Crichton, R. N., a principal manager of the London, Leith, Edinburgh, and Glasgow Shipping Company, that instead of spending money in litigating the right of landing at Newhaven, they should erect the present pier; and the Company are under lasting obligations to that gentleman for his exertions in promoting this desirable object, and for his ability and judgment in the choice of the most suitable situation.

The Magistrates of Edinburgh gave the best proof of their approbation of the plan, by their acquiescence in its erection on the place which Mr Crichton had pointed out, and by relinquishing their right of any toll or pontage. The Pier Company are also particularly indebted to Mr Scott, the proprietor of Trinity Bank, for the grant of a considerable piece of land for the site of the bridge, and for forming approaches, and erecting a convenient house for the accommodation of travellers. These material points being settled, I began to drive the piles in the month of March 1821, but there was a succession of heavy gales which rendered the operation extremely difficult and tedious. It was not until the beginning of July, that the whole of the piles were driven, and completed for carrying the standards.

The only improvement which I have attempted in the erection of Trinity Pier, is that of using strong bolts over the points of suspension, where the stress is greatest, and diminishing them towards the centre, where it is least; but not without such mechanical accuracy as to proportion every bolt to the strain which it has to bear in the curve. The extreme length of the pier is 700 feet from high-water mark, 4 feet wide, and consists of three equal divisions of 209 feet, without any central support, and is 10 feet above high-water. The pier-head is 60 feet wide by about 50 long, supported by 46 piles driven about 8 feet into stiff blue clay. The heads of the piles are secured by beams at right angles, and by diagonal trusses and warping, which at the same time form a secure frame for the deck of 2 inch plank. The front of the pier faces the north-east, and is exposed to the whole range of the sea from the entrance of the Forth. It has also to support the drag of the bridge, and therefore it is strongly sustained and backed by diagonal shores, driven in opposite directions. The intermediate piers are only subject to pressure from the weight of their respective divisions, and are greatly sheltered from the swell by the outer pier. Their area, therefore, is merely sufficient to form a secure framing for the cast-iron standard, over which the main suspending bars are supported.

The inner pier is a stone pillar of solid masonry, 6 feet square and 20 feet high. The main bars pass over the top of this pillar, similar to the standards erected on the piers. The back stay-bars form an angle of 45°; the extremities are sunk about 10 feet below the surface of the ground, and secured in hard clay by cast iron plates, on the principle of a mushroom anchor. The outer back-stays are carried in the same angle over the standard of the outer pier-head, and are morticed into a rider, which is bolted to the piles; and these riders are backed by spur-shores, to resist the drag of the bridge.

The main suspending bars are eye-bolts of 2 inches, 1⅞th and 1¾th inch diameter, being of different dimensions, for the reasons before mentioned; and are united end to end, by side-plates and bolts of proportional strength. They now become, in effect, one entire bolt; and although separately they are perfectly straight, yet they all partake of the natural curve of the arch between the points of suspension, the dip or versed line of which is 14 feet in each division.

The lowest bars are 3 inches by ¾ths thick. The ends overlap each other by crank-joints, bolted and hesped tight. They are supported in a horizontal position by perpendicular straps, passing through the joints of the main suspending bars, and the beams of the rider are laid across them, and covered with 2 inch plank. The butt ends of the beams are cased in with a neat cornice and blocking, extending the whole length of each division. On each side is a wrought-iron railing about 4 feet high; the perpendicular straps which support the bridge forming standards for the rail.

The great utility of the Trinity Pier has been already ascertained: its strength and durability, therefore, become a subject of increased importance.

Agreeably to many hundred experiments which I have made with a Machine correctly adjusted, upon the principle of the common weighing machine, I have found that it requires a force equal to 147,000 lb. to tear asunder a round bolt 1¾ inches diameter, applied in the direction of its length; but it begins to stretch with about ⅗ths of this strain when uniformly supported; and I have therefore proved the main suspending bars, connected as they are in the bridge, with 88,200 lb. or about 40 tons.

But what is much more satisfactory to the public, it has been loaded since its erection with 21 tons, subject at the same time to the ordinary weight passing over the bridge, being more than that to which, in all probability, it will ever be subjected in future.

With respect to the security of the pier, we have the advantage of experience to prove, that a structure erected upon piles securely driven into the stiff ground, will stand the violence of the sea as well as the most substantial stone buildings. Yarmouth Jetty requires no repair except what proceeds from the decay of the timber. The pier at Ostend, on the opposite coast, has stood for ages exposed to the whole force of the north wind; and at Cronstadt, in the Gulf of Finland, the batteries are erected on piles like so many islands, and are in no way affected by the violence of the sea. Piles, therefore, in such situations, are preferable to a stone pier, because no vessel could approach a solid mass of mason-work, without the most imminent danger of being dashed in pieces, or sunk by the back send of the sea, unless indeed it were to be of such extent and magnitude, as to come under the description of a Breakwater. The fact is certain, that no vessel can lie alongside Newhaven stone pier in a strong north-west gale.

The liability of the piles to decay, cannot be considered as an objection of any importance, because they can be drawn up at any time, and replaced with new ones; and even upon economical principles, they must be preferable, from their comparative cheapness, to any other materials. With respect to the durability of the iron work, it may be rendered almost imperishable, by proper attention to the usual mode of preserving it by painting; but even here there is a remedy, for every bolt may be taken out and renewed.

The Trinity Pier does not present a solid resistance to the sea, but the swell ranges through a series of piles, of sixty feet square, and is so much subdued, that vessels, unless in a decided heavy gale, can lie close enough to the stairs to land their passengers, with the greatest convenience and ease, at any time of tide; and as the principle is not limited to any particular distance, it may at some future period be carried out by a continuation of suspension arches, to admit of transports or other large ships to come alongside, and land or embark troops, whereby the unavoidable delay of going into port would be avoided. This is desirable under any circumstances; but in a military point of view, it may be of vast importance, because the success of any expedition may depend principally on the rapidity by which it is dispatched.

It would engross too great a portion of the valuable pages of the Edinburgh Philosophical Journal to enter into any speculation respecting the benefits that may hereafter be derived, from the more general adoption of bridges and piers of Suspension. But there is a purpose to which they may be applied, of no less importance than that of saving many lives from shipwreck, and even preventing that most deplorable of all human disasters.

It is perfectly well known, that when a boat has once cleared the surf, she is then considered comparatively free from danger; and that no gale, or sea, will deter our Deal boatmen from attempting to save a ship in distress. Their utmost hardihood and skill, however, are unavailable at particular times of tide in the Downs, and thousands of ships have been on the eve of destruction, without the possibility of rendering them help. I have not yet ascertained the practicability of driving piles off Deal Beach, but upon the presumption that it is to be accomplished, all other objections to a pier of suspension vanish. There is no part of the coast, where there is such a tremendous sea and surf; but I see no difficulty in proportioning the strength of the piles, and the frame of the pier, to the violent action to which they must be exposed And I would propose that boats of certain descriptions should be suspended from davits, in the same way that they are hung to the quarters of ships, ready to lower down, with their boats' crew, and every necessary appointment, to put off at a moment's notice, night or day. In the centre of the pier, I have to propose, two steps for large boats, capable of conveying off the largest anchors and cables.

My plan is not so far advanced as to enable me to enter at present into any farther details; but, from the consideration I have given the subject in all its bearings, I have great confidence in the opinion that it is neither impracticable nor difficult.

S. Brown.

London,
25, Charles Street, St James Square,
7th Nov. 1821.

Explanation of the Figures on the lower half of Plate I.

Some of the principal component parts of Captain Brown's Bridge of Suspension, copied from his specification enrolled in the Court of Chancery at Edinburgh, are represented in the lower part of Plate I.

G is a straight bolt or bar, forming one of the joints of the main lines of suspension.

H is a coupling-plate, to unite the bolts end to end.

K is one of the bolts.

I is a section of the bolt **K**.

L is a hoop for tightening up the joint, and *l* a side view of it.

MM is a side view of two bolts or bars united.

NN is a vertical view of two pair of bolts, united as above.

R is a suspending strap, and resting on the joints of two pair of joints, and supporting the lower bars of the bridge.

SS is another method of forming the main suspender by straight bolts or bars, upset at the ends to fit and be bound in a pair of clam-joints.

T shews the interior of the clam-joint.

UU shews a pair of bolts united and hooped in by the clam-joint.

V represents a third method of constructing the main suspender, by a combination of bars piled or laid laterally, and hesped tight over a joint formed by a jagged scarf.

X is a section shewing sixteen bolts or bars piled and bound together, the suspending strap resting across them, and supporting the lower bar, as in **R**.

Y is a side view of a plate, forming half of a long shackle, which may be used in removing any bolt or bar that may become defective.

Z, Z, Z is a vertical view of the above, shewing the method of fixing the shackle and removing the bolt *c e* which is represented as broken

Art. IV.—*Account of a great and extraordinary Cave in Indiana.* In a Letter from Mr Benjamin Adams to John H. Farnham, Esq. of Frankfort Ohio[*].

THE cave is situated in the north-west quarter of section 27. in township No. 3. of the second easterly range in the district of lands offered for sale at Jeffersonville. The precise time of its discovery is difficult to ascertain. I have conversed with several men who had made several transient visits to the interior of the cave about eleven years ago, at which time it must have exhibited a very interesting appearance, being, to use their own phraseology, *covered like snow* with the salts. At this period some describe the salts to have been from six to nine inches deep, on the bottom of the cave, on which lumps of an enormous size were interspersed, while the sides presented the same impressive spectacle with the bottom, being covered with the same production. Making liberal allowances for the hyperbole of discoverers and visitors, I cannot help thinking that the scenery of the interior, at this time, was highly interesting, and extremely picturesque. I found this opinion upon conversations with General Harrison and Major Floyd, who visited the cave at an early period, and whose intelligence would render them less liable to be deceived by novel appearances.

The hill, in which the cave is situated, is about four hundred feet high from the base to the most elevated point; and the prospect to the south-east, in a clear day, is exceedingly fine, commanding an extensive view of the hills and valleys bordering on Big Blue River. The top of the hill is covered principally with oak and chesnut. The side to the south-east is mantled with cedar. The entrance is about midway from the base to the summit, and the surface of the cave preserves in general about that elevation; although I must acknowledge this to be conjectural, as no experiments have been made with a view to ascertain the fact. It is probably owing to this middle situation of the cave, that it is much drier than is common.

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[*] The above is the title of a very curious paper, published as an Appendix to the first volume of the *Archæologia Americana*, which we have just received from the American Antiquarian Society. Mr Adams, the author of the letter, is the proprietor of the cave.—D. B.

After entering the cave by an aperture of twelve or fifteen feet wide, and in height, in one place, three or four feet, you descend with easy and gradual steps into a large and spacious room, which continues about a quarter of a mile, pretty nearly the same in appearance, varying in height from eight to thirty feet, and in breadth from ten to twenty. In this distance the roof is, in some places, arched; in others a plane, and in one place, particularly, it resembles an inside view of the roof of a house. At the distance above named the cave forks; but the right hand fork soon terminates, while the left rises by a flight of rocky stairs, nearly ten feet high, into another story, and pursues a course, at this place, nearly south-east. Here the roof commences a regular arch, the height of which, from the floor, varies from five to eight feet, and the width of the cave from six to twelve feet; which continues to what is called the *Creeping Place*, from the circumstance of having to crawl ten or twelve feet into the next large room. From this place to the "PILLAR," a distance of about one mile and a quarter, the visitor finds an alternate succession of large and small rooms, variously decorated; sometimes mounting elevated points by gradual or difficult ascents, and again descending as far below; sometimes travelling on a pavement, or climbing over huge piles of rocks, detached from the roof by some convulsion of nature, —and thus continues his route, until he arrives at the Pillar.

The aspect of this large and stately white column, as it comes in sight from the dim reflection of the torches, is grand and impressive. Visitors have seldom pushed their inquiries farther than two or three hundred yards beyond this pillar. This column is about fifteen feet in diameter, from twenty to thirty in height, and regularly reeded from the top to the bottom. In the vicinity of this spot are some inferior pillars, of the same appearance and texture. Chemically speaking, it is difficult for me to say what are the constituent parts of these columns, but lime appears to be the base. Major Warren, who is certainly a competent judge, is of opinion that they are satin spar.

I have thus given you an imperfect sketch of the mechanical structure and appearance of the cave. It only remains to mention its productions.

The first in importance is the Sulphate of Magnesia, or Epsom salts, which, as has been previously remarked, abounds throughout this cave in almost its whole extent, and which I believe has no parallel in the history of that article. This neutral salt is found in a great variety of forms, and in many different stages of formation. Sometimes in lumps, varying from one to ten pounds in weight. The earth exhibits a shining appearance, from the numerous particles interspersed throughout the huge piles of dirt collected in different parts of the cave. The walls are covered in different places with the same article, and reproduction goes on rapidly. With a view to ascertain this fact, I removed from a particular place every vestige of salt, and in four or five weeks the place was covered with small needle-shaped crystals, exhibiting the appearance of frost.

The quality of the salt in this cave is inferior to none; and when it takes its proper stand in regular and domestic practice, must be of national utility. With respect to the resources of this cave, I will venture to say, that every competent judge must pronounce it inexhaustible. The worst earth that has been tried, will yield four pounds of salt to the bushel; and the best from twenty to twenty-five pounds.

The next production is the Nitrate of Lime, or saltpetre earth. There are vast quantities of this earth, and equal in strength to any that I have ever seen. There are also large quantities of the Nitrate of Alumina, or nitrate of argil, which will yield as much nitrate of potash, or saltpetre, in proportion to the quantities of earth, as the nitrate of lime.

The three articles above enumerated are first in quantity and importance; but there are several others which deserve notice, as subjects of philosophical curiosity. The Sulphate of Lime, or plaster of Paris, is to be seen variously formed; ponderous, crystallized and impalpable or soft, light, and rather spongy. Vestiges of the sulphate of iron are also to be seen in one or two places. Small specimens of the carbonate, and also the nitrate of magnesia, have been found. The rocks in the cave principally consist of carbonate of lime, or common limestone.

I had almost forgotten to state, that near the forks of the cave are two specimens of painting, probably of Indian origin. The one appears to be a savage, with something like a bow in his hand, and furnishes the hint, that it was done when that instrument of death was in use. The other is so much defaced, that it is impossible to say what it was intended to represent.

ART V.—*Observations on the Production of Electricity by Contact.* By C. G. GMELIN, Professor of Chemistry in the University of Tubingen. Communicated by the Author.

SIR HUMPHRY DAVY, in his treatise on the chemical effects of electricity, published, in the year 1806, some experiments, which, in a very simple and unequivocal manner, seemed to prove the electrical opposition between Alkalies and Acids,—an opposition well established by the action of galvanic electricity upon the combination of alkalies and acids. He discovered, that acids which may be exhibited in a dry state, such as *Oxalic*, *Succinic*, *Benzoic*, *Boracic*, *Phosphoric* acid, having the form of crystals, or that of a powder, if touched on an extensive surface, with a copper-plate, insulated by a glass handle, were negatively electrified, while the copper-plate was positively electrified; and that, on the contrary, alkalies and earths, as *Lime*, *Strontia*, *Magnesia*, were positively electrified, while the copper was negatively electrified. Zinc and tin, when tried instead of copper, produced the same effect. The intensity of the positive charge of the metal, appeared to be the same, whether the acid was insulated by glass, or in communication with the earth.

I must own, that several reasons induced me to put some distrust in the justness of the conclusions drawn from the above experiments.

1. Because Sir H. DAVY himself has found, that if the temperature changed a little, as for instance, if the earths were touched during their cooling, the opposite state of electricity often appeared.

2. Because in those experiments the Condenser was employed, an instrument, which may so easily be a source of errors, and which at any rate unnecessarily prolongs the experiment.

3. It appeared to me very improbable, that those pulverulent bodies should turn out so very different in their electrical relation towards the metals, considering that the opposition between acids and bases is not an absolute, but only a correlative one, and that it might be impossible to anticipate the relation of silica for instance, and of those bodies in general, which are possessed neither of a marked acid, nor of a basic nature.

When I touched magnesia with a plate of zinc, the diameter of which was =7½ Par. inch, with due regard to the precautions necessary in those experiments according to Sir H. DAVY, the *Zinc* was found *positively*, the *Magnesia negatively* electrified. In this experiment I had employed the electrometer of VOLTA, with its condenser. By this contrary result, I was induced to repeat the greatest part of Sir H. DAVY's experiments.

In order to avoid repetitions, I shall premise all that is common to the following experiments.

I employed always the new electrometer, with the two Zambonic piles, described by Professor BOHNENBERGER, in the "Tubinger Blatter," which is very nicely executed by M. BUZENGEIGER of Tubingen *.

From the superior sensibility of this instrument, the use of the condenser was superseded, and the species of electricity was immediately indicated.

The substances were heated in a covered platina crucible, and ignited, when their nature allowed it. The crucible, when still hot, was put on a bath of dry mercury, and covered with a perfectly dry glass. Thus, the substance in the crucible assumed the temperature of the surrounding atmosphere, without having been in contact with the air. Twenty-four hours passed; it was touched, still confined in the crucible, with round plates of zinc or copper, of a diameter = 2 Par inches, insulated by a glass handle.

No difference was perceived, whether the substance was insulated or not.

The experiments were always, if the contrary is not expressly noticed, insulated in a dry and fine season, and the temperature varied from +12° to +16° of Reaumur But as I have found no difference in this respect, provided the substances had been fully protected from moisture, and assumed the temperature of the surrounding atmosphere, I shall not repeat these particulars in the account of every experiment.

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* This curious Electrometer is described in vol. iv. p. 324. of this Journal

It must farther be observed, that the evolved electricity was always more intense, if the contacts were made with some pressure, (avoiding, however, a motion to and fro,) than if the metallic plates were but lightly placed upon the powdered substance. It might therefore be suspected, that the evolution of electricity in these experiments in general, depends upon friction; but, on the other hand, it must be owned, that a contact, if joined with pressure, is more perfect; and it will appear hereafter, that substances of a rough nature, where the friction ought to be the greatest, are just those which acquire either no electricity whatever, or only a very weak one.

I shall now proceed to the experiments themselves.

The first substance which I tried was magnesia, as it occurs in commerce, and which contains some lime.

Having been ignited, it imparted to the metal, when still quite hot, by a single contact, an intense negative electricity. After a short time, a point of indifference appeared; the metal shewed, during some time, no traces of electricity. Very soon after, the opposite state of electricity was evolved, the metal was positively electrified, and the experiment could now be repeated several days with the same result.

I now prepared a perfectly pure magnesia, by dissolving pure crystals of sulphate of magnesia in water, and precipitating the boiling solution by subcarbonate of potash, free from silica, and so on. This magnesia imparted to the metal, *under all circumstances*, a positive electricity; being itself negatively electrified, both when it was *quite hot*, and when it had assumed the temperature of the atmosphere. The evolved electricity was intense to such a degree, that the gold leaf touched the pile after a single contact.

This experiment, which was very often repeated, appeared to [illegible] the experiments of Sir H. DAVY so fully, that they scarcely seemed to require any farther refutation.

Burned Carrara marble, which was perfectly freed from carbonic acid, by slacking it in a platina crucible, and strongly igniting it again, commonly imparted to the metal, after cooling, a negative electricity. This was found, in some instances, pretty intense; but, in most cases, it was so weak, that repeated contacts were wanted to render it sensible. The same result was obtained, when the lime was much hotter than the surrounding atmosphere. In one instance, the metal became positively electrified, when the lime had been put in a perfectly dry bottle, which was well stopped by a cork and wax-paper, and left remaining for twenty-four hours, and then its contents poured upon a glass plate. In another instance, the metal likewise became positively electrified, but not intensely; in which case, the contents of the platina crucible, which had previously assumed the temperature of the atmosphere, were put in a dry porphyry mortar, so that the lower surface of the lime, which was touched by the zinc plate, became the upper one. By means of friction, however, the metal appeared always to be intensely negatively electrified.

I repeated now, the experiment with burned oyster shells, which, as it is well known, likewise give a pretty pure lime. The metal was in this case, as long as the crucible was still hot, always positively electrified; and shewed, even when the crucible had assumed the temperature of the atmosphere, a positive, though not intense electricity. This positive electricity appeared, when the surface of the lime in the platina crucible itself was touched by an insulated zinc plate. The metal was likewise always positively electrified, when it was rubbed with this kind of lime.

Whilst, therefore, the lime from Carrara marble, by its contact with zinc, generally acquires a positive electricity, the lime from oyster shells acquires by its contact with zinc a negative electricity.

It seemed to be interesting to find out the cause of this difference. The first that occurred to me as the probable cause, was the different external condition of the two kinds of lime. The lime from Carrara marble was very rough, while the lime from oyster shells exhibited a very soft powder.

By examining the Carrara marble, I found that it contains some magnesia. The lime extracted from oyster shells contains traces of sulphuret of lime, phosphate of lime, magnesia, and oxide of iron. I prepared, therefore, a perfectly pure lime, by dissolving Carrara marble in nitric acid, and digesting the solution with burned and slacked Carrara marble. Thus the trace of iron and magnesia was precipitated. The filtrated solution was then precipitated by carbonate of ammonia; the precipitate thoroughly washed, was burnt in a platina crucible, and made perfectly caustic in the manner above described.

But even this perfectly pure lime had a rough surface, and rendered the metal negatively electrified, though not intensely. When this lime was finely powdered in a hot porphyry mortar, and again heated in a platina crucible, and cooled, the zinc plate assumed constantly an intense positive electricity. Even after several weeks, during which time the lime was kept in a well closed bottle, the metal became positively electrified by its contact with the lime.

It seems to follow from these experiments, that the species of electricity, which is evolved, does not depend upon the chemical nature of the substance which is touched, but rather upon its physical constitution.

Caustic strontia, likewise, obtained by igniting pure nitrate of strontia, rendered the metal, positively electrified, though weakly, when it had been finely powdered. I tried also caustic potash and soda, but without a satisfactory result.

Yttria, purified from the oxide of cerium, according to the method of BERZELIUS, imparted to the metal such an intense positive electricity, even when touched on a very small surface, (the diameter of the zinc plate was only=1 inch, 7½ lin. Par.), that the gold leaf touched the pile by a single contact.

Beryllia, on the contrary, imparted to the metal, under all circumstances, an intense negative electricity. This circumstance is the more singular, as this earth, in its external characters, much resembles magnesia.

By *Silica*, the metal was constantly positively electrified, but the effect ceased soon after it had been exposed for some time to the air.

Oxide of Zinc, carefully prepared, imparted to the zinc plate, by a single contact, a very intense positive electricity.

Oxide of *Cerium*, prepared according to the method of LAUGIER, gave the same result. Crystallised and fused *boracic acid* constantly imparted to the metal a positive electricity.

Vitrified *phosphoric acid*, prepared from phosphorus by nitric acid, gave no result. When ignited in a platina crucible to red heat, and then cooled, it shewed no electricity whatever, by touching it with the zinc plate; and when ignited to a white heat, the acid evaporated in white acid vapours.

Oxalic acid made the metal constantly positively electrified when crystallised; and when in the form of a powder (hydrate of oxalic acid) the evolved electricity was very weak.

I now tried several salts.

Pure carbonate of barytes imparted to the metal constantly, and under all circumstances, an intense positive electricity.

Carbonate of Soda fused, and still very hot, imparted to the metal a very intense negative electricity. When it had assumed the temperature of the atmosphere, the metal was sometimes positively, sometimes negatively electrified.

I now allowed some crystallised carbonate of soda to effloresce perfectly. If it was touched in this state, the metal was constantly positively electrified, when the salt and the metal had assumed the temperature of the atmosphere; and even when the salt and the metal were of a higher temperature, the metal was commonly positively electrified, and in a few instances negatively.

It appears, therefore, again, that the very same body, when only in a different state, may be positively or negatively electrified, by its contact with metals.

Crystals of sulphate of potash, ignited and powdered, imparted to the metal, when still quite hot, a weak positive electricity; but this was so much increased on cooling, that though the weather was very damp, the gold leaf touched the pile, after a few contacts.

Sulphate of Soda, when quite freed from its water of crystallisation by its exposure to a dry atmosphere, rendered the metal positively electrified.

The general result of these experiments is therefore this, that the electrical opposition between acids and bases, though so well established by other means, cannot be deduced from the electrical relation between these bodies and metals.

Art. VI.—*On the Coral Islands of the Pacific Ocean.*—By Dr A. von Chamisso *.

THE low islands of the South Sea and Indian Ocean owe their origin principally to the operations of several species of coral.

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* Published in the Appendix to Kotzebue's Voyage of Discovery into the South Sea and Beering's Straits, vol. iii. p. 331.

Their situation with respect to each other, as they often form rows, their union in several places in large groups, and their total absence in other parts of the same seas, induce us to conclude, that the corals have founded their buildings on shoals of the sea; or, to speak more correctly, on the tops of mountains lying under water. On the one side as they increase, they continue to approach the surface of the sea, on the other side they enlarge the extent of their work. The larger species of corals, which form blocks measuring several fathoms in thickness, seem to prefer the more violent surf on the external edge of the reef; this, and the obstacles opposed to the continuation of their life, in the middle of a broad reef, by the amassing of the shells abandoned by the animals, and fragments of corals, are probably the reason that the outer edge of the reef first approaches the surface. As soon as it has reached such a height, that it remains almost dry at low water, the corals leave off building higher; sea-shells, fragments of coral, shells of echini, and their broken off prickles, are united by the burning sun, through the medium of the cementing calcareous sand, which has arisen from the pulverisation of the above-mentioned shells, into one whole or solid stone, which, strengthened by the continual throwing up of new materials, gradually increases in thickness, till it at last becomes so high, that it is covered only during some seasons of the year by the high tides. The heat of the sun so penetrates the mass of stone when it is dry, that it splits in many places, and breaks off in flakes. These flakes, so separated, are raised one upon another by the waves at the time of high water. The always active surf throws blocks of coral (frequently of a fathom in length, and three or four feet thick,) and shells of marine animals, between and upon the foundation stones; after this the calcareous sand lies undisturbed, and offers to the seeds of trees and plants cast upon it by the waves, a soil upon which they rapidly grow, to overshadow its dazzling white surface. Entire trunks of trees, which are carried by the rivers from other countries and islands, find here, at length, a resting place, after their long wanderings; with these come some small animals, such as lizards and insects, as the first inhabitants. Even before the trees form a wood, the real sea-birds nestle here; strayed land-birds take refuge in the bushes.

and at a much later period, when the work has been long since completed, man also appears, builds his hut on the fruitful soil formed by the corruption of the leaves of the trees, and calls himself lord and proprietor of this new creation.

In the preceding account, we have seen how the exterior edge of a sub-marine coral edifice first approaches the surface of the water, and how this reef gradually assumes the properties of land; the island, therefore, necessarily has a circular form, and, in the middle of it an inclosed lake. This lake, however, is not entirely inclosed; (and it could not be, for, without supply from the sea, it would soon be dried up by the rays of the sun); but the exterior wall consists of a great number of smaller islands, which are separated from each other by sometimes larger, sometimes smaller spaces. The number of these islets amounts, in the larger coral islands, to sixty; and between them it is not so deep, but that it becomes dry at the time of ebb. The interior sea has, in the middle, generally a depth of from thirty to five and thirty fathoms; but on all sides towards the land, the depth gradually decreases. In those seas where the constant monsoons prevail, where consequently the waves beat only on one side of the reef or island, it is natural that this side of the reef, exposed to the unremitting fury of the ocean, should be formed chiefly by broken off blocks of coral, and fragments of shells, and first rise above the elements that created it. It is only these islands, respecting the formation and nature of which we hitherto know any thing with certainty; we are still almost entirely without any observations on those in the Indian and Chinese sea, which lie in the regions of the six months monsoons. From the charts given of them, it is to be inferred, that every side is equally advanced in formation. The lee-side of such a coral-reef in the Pacific Ocean, which is governed by the constant monsoons, frequently does not shew itself above the water, when the opposite side, from time immemorial, has attained perfection in the atmospheric region; the former reef is even interrupted in many places by intervals tolerably broad, and of the same depth as the inner sea, which have been left by nature, like open gates for the exploring mariner to enter the internal calm and secure harbour. In their external form the coral islands do not resemble each other, but this, and the extent of each, probably depends on the size of the sub-marine mountain tops, on which their basis is founded. Those islands which have more length than breadth, and are opposed in their greatest extent to the wind and waves, are richer in fruitful islets than those whose situation is not so adapted to a quick formation. In the large island-chains, there are always some single islets which have the appearance of high land: these lie upon an angle projecting into the sea, are exposed to the surf from two sides, consist therefore almost entirely of large blocks of coral, and are destitute of smaller fragments of shells and coral sand to fill up the intervals. They are, therefore, not adapted to support plants requiring a depth of soil, and only afford a basis to high trees, provided with fibrous roots, (as the *Pisonia*, *Cordia Sebastiana*, L.; *Morinda citrifolia*, L., and *Pandanus odoratissimus*, L.) which, at a distance, give to these, always very small, islands the form of a hill. The inner shores of the island, exposed to the surf, consist of fine sand, which is washed up by the tide. Between the small islands under their protection, and even in the middle of the inner sea, are found smaller species of coral, which seek a quiet abode, form in time, though very slowly, banks, till they at last reach the surface of the water; gradually increase in extent, unite with the islands that surround them, and at length fill up the inner seas, so that what was at first a ring of islands, becomes one connected land. The islands which are so far formed, retain in the middle a flat place, which is always lower than the wall that surrounds them on the banks; for which reason pools of water are formed in them after a continued rain,—the only springs and wells they possess. One of the peculiarities of these islands is, that no dew falls in the evening, that they cause no tempests, and do not check the course of the wind. The very low situation of the country sometimes exposes the inhabitants to great danger, and threatens their lives, when the waves roll over their islands, if it happens that the equinox and full moon fall on the same day, (consequently, when the water has reached its greatest height,) and a storm agitates the sea at the same time. These islands are said to be also shaken by earthquakes. but what is peculiar on the

ART. VII.—*Observations on the Final Report of the Commissioners of Weights and Measures, by the* Reverend GEORGE SKENE KEITH, D. D. In a Letter to Dr BREWSTER.

SIR, *Manse of Keith-hall, November* 8. 1821.

IN the last number of the Philosophical Journal, you gave the substance of the third or final Report of the Commissioners of weights and measures, viz. Sir George Clerk, Bart., Davies Gilbert, Esq. M. P., Dr Wollaston, Dr Young, and Captain Kater.

As I have, for above thirty years, paid particular attention to the equalization of the weights and measures of Great Britain, I beg leave to submit the following observations on this report, with the greatest respect for the gentlemen on whom the commission was devolved, and of whose abilities and character there is but one, and that a very high opinion in the kingdom. I have not the honour of being known to any of these gentlemen, except to Davies Gilbert, Esq. who kindly shewed me a copy of the whole report in May last, when I was attending a Committee of the House of Commons, of which he was Chairman; and I equally respect his talents, patriotism, and his integrity.

I have great pleasure in making two general remarks on their Report.

1. The Commissioners have, with equal propriety and accuracy, fixed the proportion between the English yard made by Mr Bird, and the length of the pendulum which vibrates seconds at London in a vacuum and at the level of the sea. Captain Kater has great merit in determining this length, which is found to be 39.1393 inches.

2. As English Troy weight is the only legal standard both of weights and of coins, in this kingdom, the Commissioners acted very properly in preserving it, as the standard to which all other weights are to be compared; and they judged right in fixing a definite proportion between the Avoirdupois pound, now generally used, (which ought by law to contain 16 Troy ounces, or 7680 grains, but now contains only 7000 Troy grains), and

the standard Troy pound of 5760 grains, which has been for many centuries the legal weight of England, though it is larger than the old Tower pound of London.

But though I highly approve of those great articles, I must object to some other parts of their report, while I assign my reasons for differing from them in opinion, and state some facts which may merit the public attention. It is the peculiar advantage of mathematical science, and shews its great superiority over logical discussion, that its truths can be clearly demonstrated, and that where there is any, the quantum of error can often be accurately ascertained. Yet it should always be remembered, that as Achilles could be wounded in the heel, so a mathematician is vulnerable in his data. Therefore, I observe, *first*, concerning the temperature at which these standards were fixed, and are afterwards to be verified,—namely, 62° of Fahrenheit, that this degree of heat does not appear so proper, as if it had been fixed at 40°, or 39½°, the temperature at which water is most concentrated, or occupies the least volume. In the days of Sir Isaac Newton, 50° was reckoned the standard of moderate temperature. About sixty years ago this was estimated at 55°, which still continues to have the mark of *temperate* affixed to the scale of our thermometers. But in 1790 and 1792, in the very accurate experiments of Sir Charles Blagden and Mr Gilpin, 60° was assumed as the standard of temperate heat, while they ascertained the specific gravity of ardent spirits of various degrees of strength, and from 30° to 80° of Fahrenheit's thermometer. Of late, this standard has been raised to 62°; or that degree at which it is said one feels comfortable in a room; and, in the progress of luxury, it may rise to 70°. But as there is a particular degree of heat, at which water occupies the least bulk,—as distilled water of 40° is extremely near, in point of specific gravity, to common water of 60° or 62°, as different thermometers, and different degrees of temperate heat are used in different countries, and by different persons, and as it was ascertained by Mr Everard and a Committee of the House of Commons in 1696, that an English cubic foot of common water of a moderate temperature, contains very nearly 1000 Avoirdupois ounces, (only 10.4 grains less, or exactly 437489.4 grains), I cannot help thinking that the heat of distilled water should have been fixed at 40°, and that of common water at 60° or 62°. The lower temperature of distilled water would have compensated for the greater specific gravity of common water; and both would have coincided, or very nearly corresponded with 1000 Avoirdupois ounces to the cubic foot of water.

Secondly, The Commissioners appear to me to have proposed an improper size of a common gallon for malt-liquor and corn measures, without taking care that the wine gallon should be of the same dimensions with that standard. The common gallon, which they recommend, is said by them to contain 277.3 cubic inches. A number of objections may be made to a gallon of these dimensions. If carried into execution, it would occasion a complete change both of our dry and liquid measures. The present standard corn-bushel is that of 1601, in the reign of Queen Elizabeth, and contains only 2124 cubic inches. The gallon derived from it, or the eighth part of that bushel, is 265$\frac{1}{2}$ cubic inches, or 11.8 inches, nearly $\frac{1}{24}$th part less than the proposed common gallon. The ancient legal bushel, that of Henry VII. which was mentioned by Mr Everard in 1696 as above mentioned, contained 2145.6 cubic inches, and the gallon, or eighth part of this, is 268.2 inches, which is 9.1 inches or $\frac{1}{28}$ or 3.4 *per cent.* less than the proposed gallon. The common bushel of Excise, by which the malt duties are charged, is 18 inches in diameter and 8 inches deep, contains 2150.42 cubic inches, and was fixed upon by Parliament in 1696, as a near approximation to the standard of Henry VII. The gallon derived from this, is 268.8 inches, or $\frac{1}{31}$st part, or 3$\frac{1}{5}$th *per cent.* less than the proposed common gallon, which, instead of being a measure of a *mean* value, is considerably *larger than any of the corn gallons*, derived from those legal bushels. If compared with the ale gallon that is *generally used in commerce*, which Lord Godolphin got measured in 1707, and which contains 261.36 cubic inches, the proposed gallon of 277.3, is 16 cubic inches, or 6 *per cent.* larger. If compared with the Excise gallon of 282 inches, or the standard quart which is nearly one-fourth of that quantity, it is no doubt of less dimensions. But neither of these measures is *used in commerce*; though the ale and beer *duties are charged* at that large rate of the gallon, in order to give a small allowance in favour of the brewer. If we next compare the wine gallon of Excise, which contains 231 cubic inches, or according to the dimensions of the 5th of Queen Anne 230.907 inches, the proposed gallon of 277.3 inches, is almost exactly a fifth part larger; but that wine gallon is not used in the wine or spirit trade, though it was meant to give the fair trader an advantage, at a time when taxes were less familiar, and less strictly exacted, than at present. The gallon used in trade is the Guildhall gallon of 224 inches, as measured by Mr Flamstead, Dr Halley and others, in 1688. In every view, therefore, the proposed gallon is not a mean value between any of our legal gallon measures used in commerce. I would further remark, that a gallon measure filled with ten Avoirdupois pounds, or 70,000 English Troy grains of distilled water at 62°, does not contain 277.3 cubic inches, but only at the rate mentioned in the report, of 252.72 grains to the inch, 276.98 inches, and if either common water of a moderate temperature, or distilled water at 40° of heat were used, would contain only 276.48 cubic inches. There is a discrepancy between these of $\frac{1}{863}$ in the first case, and of $\frac{1}{334}$ in the second, which would not merit any regard, if it existed between the proposed standard, and any of the existing national gallon measures, but is too much to be allowed between two standards, or two ways of making or computing the proposed standard, which ought exactly to agree with each other. But if it is wished, and it certainly is desirable, to establish a common gallon for corn, wine, oil, malt-liquor, and ardent spirits, or for both liquid and dry measures, instead of adopting one from ten Avoirdupois pounds of water, or of 277.3 cubic inches, I humbly apprehend that this common mean gallon should contain 270 cubic inches, the bushel derived from it 2160 inches, the quarter 10 cubic feet, and the last of corn 100 such feet. As the near correspondence between the bushel of 2150.42 inches established for imposing the malt duties, and the above bushel of 2160 cubic inches (where the difference is only 9.58 inches on the bushel, or only 1.2 on the gallon, or $\frac{1}{225}$th part), could be easily raised to a perfect coincidence; as a bushel of 2160 cubic inches would contain 1250 ounces Avoirdupois of common water, and a gallon of 270 inches would contain 156¼ ounces, or 9 pounds 12 ounces and 4 drams Avoirdupois of distilled water at 40°, or common water at 62°; the adoption of these measures would preserve, and even improve the connexion between the English quarter, and 10,000 Avoirdupois ounces; And the being obliged to use ounces and quarters of an ounce, in making or proving a gallon measure, and ounces as well as pounds in verifying a bushel, would occasion more accuracy than if a round number of pounds was made the standard of either the bushel or the gallon. It deserves, also, here to be considered, that the actual wine gallon of commerce, which contains 224 inches, wants a fifth part of the contents of the gallon here recommended; that, in fact, most of the gallon measures in the wine and spirit trade contain 225 inches, so that a fifth part added to the price of the gallon, which these dealers use at present, could easily be added, and a common gallon for both liquid and dry measures would not be obnoxious to them or their customers. It may also be mentioned, that by scooping out a very little from the inside of a wooden corn measure, it could easily be adjusted to the standards of 270 inches for the gallon, 540 for the peck, and 2160 for the bushel: And it may be added, that though the common brewer might not be willing to give 277.3 cubic inches for every gallon of his ale or beer, when he is only allowed 282 inches to himself, or 4.7 inches to supply his loss from both waste and absorption, he might be willing to raise the size of his gallon to 270 inches, having still 12 inches of difference between the gallon of Excise, according to which he pays taxes, and the common gallon of commerce, at which he sells his malt liquor. Here justice requires that *the taxes* on ale, spirits, wine and malt, should be *either proportioned* to the contents of this common gallon, or *continue to be charged according to the present laws of Excise.* The great object is to get the standards which *are used in commerce*, simplified, and the measures both made with great accuracy, and established with as little trouble as possible. The establishing a common gallon of 277.3 will occasion much inconvenience and great expence,—ten times as much as would be occasioned by using a gallon of 270 cubic inches; would destroy all connection between the English quarter and 10 cubic feet, which ought to be increased or confirmed; and by raising the dimensions of our standard corn measures 4⅓ *per cent.* would prevent frauds, or render them useless. After all, it may be well worth considering, whether, as a multitude of provincial standards must be laid aside, it would not be advisable to take a correct and invariable standard from nature, the pendulum that vibrates seconds for example; to divide this decimally,—to establish either a cube or a cylinder of its dimensions, filled with distilled water of 40° of heat, or with common water at a moderate temperature, as a standard tun-weight, and also for both dry and liquid measures of capacity,—to get weights and measures made correctly from this standard,—to send them to all the market-towns, and to put them under the inspection of the Magistrates; but to *compel no man* to use them unless he choose to do so. By dividing the denominations of this standard, not into 2, 4, 8, 16, as at present with some weights; far less into 7, 14, 28, 112; but into 1, 2, 3 and 4 of the next inferior denomination, 24 pieces of metal could weigh out 1,111,110 different weights, or *three* corn measures, with boards of partition having 1 and 4 tenths of their measure on one side, and 2 and 3 tenths on the other, could measure out 1110 different quantities of corn, and a merchant's apprentice could perform an operation in reduction of decimal fractions, merely by measuring or weighing his goods. In a short time, the new weights and measures, *which ought to be called Commercial ones*, would become familiar,—would, from their simplicity and accuracy be gradually introduced, and would in a few years become general, when they might be established. But till that time, no authority higher than the influence of fashion and example should be exerted, no compulsion, no licenses, no fines should be introduced. These things would defeat the object intended to be accomplished; for men will not be dragooned into any public measure, even though its adoption were advantageous; yet if left to themselves, they will embrace what will promote their interest.

I would conclude these observations by relating a fact consistent with my knowledge.

A clergyman, with whom I was intimately acquainted, had a servitude of a footpath which led diagonally through a valuable field, part of his glebe or parsonage lands, and along which the people as they passed to or from the church could look in, both at the front and gable windows of his house. Their weekly visits both annoyed him and injured the field through which they travelled; and as he could not get free of this servitude by compulsion, he had recourse to art. He made out a very good gravel walk, and frequented it daily for some time, as if it had been made for his private use and amusement. Winter came on, a good deal of rain fell, and the diagonal footpath became very dirty and unpleasant to the people going to church, or returning home. A few of them ventured to try, whether the Minister would allow them the use of his fine gravel walk; and when they were not interrupted, others soon followed their example. In a little time they all deserted the diagonal footpath, and went along the gravel walk, which, though a little longer, was a much better road, and by which they could walk nearly as soon, and with much more comfort.

It is in this way, I apprehend, that the Legislators of this free and great commercial country should proceed, in equalizing our weights and measures. They should make new and correct standards, decimally divided. They should send them to the market-towns, and put them under the protection of the Magistrates, along with accurate tables shewing their relation to the other national and provincial weights and measures. They should use them themselves, and promote resolutions for that use, but employ no compulsion for their introduction; while they punish severely all frauds in those who use the old or provincial standards. If established on sound principles, the people will soon generally adopt them; and at no distant period they will be introduced and established among all trading nations.

I am, yours, &c.

GEO. SKENE KEITH.

ART. VIII.—*Remarks on Azalea, Rhododendron, Ledum, and Leiophyllum; with Characters of these four Genera.* By Mr DAVID DON, Curator of the Lambertian Herbarium.

THE genus *Azalea*, as established by Linnæus, and adopted by Jussieu, Schreber, and in short by every botanical writer, includes many plants which are not to be distinguished from *Rhododendron*, unless by the number of stamens, which in *Azalea* is commonly five, and in *Rhododendron* ten. These numbers, however, are so variable, that they cannot be regarded as of sufficient importance to constitute a generic character. Thus, for example, *Azalea indica* and *lapponica (Rhododendron lapponicum*, Wahlenb. Fl. Lapp.) are often observed to have eight and ten stamens. In the Lambertian Herbarium, is a specimen of a shrub *(R. hispidum* mihi) from Japan, very near akin to *Azalea indica*, the flowers of which have uniformly ten stamens. The striking affinity which exists among these plants may in some measure account for the facility with which they are known to unite in the production of hybrid varieties. The genus *Azalea* must now, therefore, be limited to *A. procumbens*, a species which affords abundant marks of distinction, and is the only one indigenous to Britain. This little shrub agrees in many points with *Leiophyllum buxifolium (Ledum buxifolium*, Hort. Kew.,) but the latter differs from it, in having a 5-petaled corolla and projecting stamens; and from *Ledum* it is distinguished by its calyx; by the bursting of its antheræ; by the dehiscence of its capsule; by the structure of the columella; and, lastly, by the form of its seeds. In order to point out the characters of these genera, as now constituted, I shall subjoin descriptions of all of them.

AZALEA.—AZALEÆ species *Linn.*

Calyx profundè 5-partitus, persistens. *Corolla* brevis, campanulata, 5-fida. *Stamina* 5, hypogyna, corollâ breviora: filamenta plana, glabra: antheræ subrotundæ, laterales, nudæ, biloculares, internè longitudinalitèr rumpentes. *Pistillum* 1, staminibus brevior: germen subrotundum: stylus rectus, simplex: stigma capitatum. *Capsula* parva, subrotundo-ovata, stylo persistente rostrata, 5-locularis, 5-valvis, apice septicido-dehiscens: valvis ovatis: marginibus introflexis, remotis, rectis. *Columella* subovata, teretiuscula, rugosa, basi gibbosa. *Semina* ∞, minuta, lævia, aptera. *Fruticulus* depressus, ramosissimus, procumbens, sempervirens, foliosus, rigidus. *Folia* opposita, parva, elliptica, integerrima, coriacea, glabra, nitida, margine revoluta. *Flores* parvi, rosei, pedicellati, in umbellulis numerosis, terminalibus dispositi.

Sp. 1. procumbens.

Azalea procumbens, *Linn*

RHODODENDRON.—*Linn. Juss.*

Azalea sp. omnes (præter *A. procumbentem*) *L. Juss.* *Calyx* profundè 5-partitus, persistens. *Corolla* campanulata vel infundibuliformis (in *paucis* rotata): limbo 5-lobo: lobis latis, planis, æqualibus rariùs inæqualibus. *Stamina* 5–10, declinata, in disco hypogyno inserta, sæpiùs corollâ multò longiora: filamenta gracilia, basi hirsuta: antheræ oblongæ, apice foraminibus geminis aperientes. *Pistillum* 1: stylus simplex, declinatus, staminibus longior: stigma capitatum, sæpiùs emarginatum. *Capsula* oblonga, cylindracea, 5-sulca, 5-locularis, 5-valvis, apice dehiscens: valvis lineari-oblongis: marginibus introflexis, approximatis. *Columella* tetragona. *Semina* ∞, compressa, scobiformia, alâ membranaceâ cincta.

Fructices rariùs arbores, ramosissimi, rigidi, sempervirentes vel decidui. *Folia* alterna, integerrima, in aliis coriacea, in aliis membranacea, nunc glaberrima nunc hirsuta. *Flores* (in *pluribus* magni) pedunculati, purpurei, coccinei, rosei vel albi, in aliis aurei vel crocei, in corymbis subspicatis, terminalibus dispositi, rariùs solitarii aut laterales. Per hyems flores futuri in hybernaculo squamis numerosis densè imbricato strobilem mentiente inclusi.

The genus *Rhodora* differs from *Rhododendron* in the anomalous structure of its corolla, which is separated into three petals, slightly united at the base; the upper one is thrice broader than the two lower ones, is 3-lobed, and resembles the half of the corolla of a *Rhododendron:* the two lower ones are spreading, and have the form of ordinary petals. This singular structure of corolla, proves the correctness of M. De Candolle's ingenious hypothesis, regarding the cohesion of petals in monopetalous corollas *.

I doubt much, if the figure of the corolla, unattended by any other difference in structure, is to be considered alone sufficient, in this order, to constitute a generic division. Indeed *Rhodora* is so intimately allied to *Rhododendron*, that it may hereafter be found expedient to unite them. The figure of the corolla varies much in different species of *Rhododendron*; and, therefore, affords excellent specific characters, such as in *R. anthopogon, dauricum, chamæcistus, chamtschaticum*, &c.

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* Theorie Elementaire de la Botanique, p. 112.

LEDUM.—*Linn. Juss.*

Calyx minimus, 5-dentatus, deflorato evanescente. *Corolla* 5-petala, patens. *Stamina* 10, in disco hypogyno inserta, corollâ longiora: filamenta capillaria: antheræ subrotundæ, apice poris geminis aperientes. *Pistillum* 1: germen subrotundum: stylus filiformis, rectus, staminibus brevior: stigma parvum, capitatum. *Capsula* subrotundo-ovata, 5-locularis, 5-valvis, basi septicido-dehiscens: valvularum marginibus introflexis, approximatis. *Receptaculum* 5-lobum, columellâ 5-angulâ pedicellatum. *Semina* ∞, plana, linearia, scobiformia, utrinque in alâ membranaceâ desinentia.

Fruticuli ramosissimi, erecti vel decumbentes. *Ramuli* juniores, tomentosi. *Folia* alterna, nunc linearia, nunc lanceolata aut elliptica, margine integerrima et revolata, supra nuda, reticulatìm venosa, subtus lanâ fulvâ instructa; quandò contrita odorem aromaticum emittunt. *Flores* albi, pedicellati, in corymbis terminalibus densi.

LEIOPHYLLUM.—*Persoon Syn.*

Ammyrsine *Pursh.* Ledi species *Hort. Kew. et Willd.* *Calyx* profundè 5-partitus, persistens. *Corolla* 5-petala, hypogyna. *Stamina* 10, hypogyna, corollâ longiora: filamenta capillaria, glabra: antheræ subrotundæ, laterales, internè longitudinaliter rumpentes. *Pistillum* 1: germen subrotundum, glabrum: stylus filiformis, gracilis, rectus, staminibus longior: stigma parvum, capitatum. *Capsula* subrotundo-ovata, stylo persistente rostrata, 5-locularis, 5-valvis, rariùs 3-locularis, 3-valvis, apice septicido-dehiscens: valvis ovatis: marginibus introflexis, remotis, rectis. *Columella* subovata, teretiuscula, rugosa. *Semina* ∞, minuta, lævia, aptera.

Fructiculus erectus, ramosissimus, sempervirens, rigidus, foliosus. *Folia* sparsa, parva, ovalia, plana, integerrima, coria-

cea, glabra, lucida. *Flores* parvi, albi, pedicellati, in corymbis terminalibus numerosi.

Sp. 1. buxifolium.

Leiophyllum buxifolium. *Elliott fl. Carol. et Georg.* 1. *p.* 457. Leiophyllum thymifolium, *Persoon Syn.* 1. *p.* 477. Ammyrsine buxifolia. *Pursh. fl. Amer. sept.* 1. *p.* 301. *Bot. Regist. t.* 531. Ledum buxifolium, *Hort. Kew.* 2. *p.* 65. *Berg. Act. Petrop.* 1777. *p.* 213. *t.* 3. *f.* 2. *Willd. sp. pl.* 2. *p.* 602. *Mich. fl. Amer. bor.* 1. p. 260. Ledum thymifolium, *Lam. Encycl.* 3. *p.* 459. *illust. gen. t.* 363. *f.* 2.

Art. IX.—*On the Geographical Distribution of Insects.* By M. Latreille. (Concluded from Vol. V. p. 378.)

Many lepidopterous insects, which form particular groups, and a variety of other species, will remain a long time unknown. All the successions of species spread themselves gradually from east to west, and reciprocally. Many of those which are found in the provinces of Normandy and Brittany, inhabit also the southern parts of England. The departments situated on the left bank of the Rhine, to the north, have, in this respect, a community of species with the neighbouring provinces of Germany. Some of the Levant species, such as the *Cantharis orientalis*, the *Mylabris crassicornis*, a beautiful variety of the *Melolontha occidentalis*, brought by Olivier, and some of the diurnal Lepidoptera, appear to have travelled towards the west, and to have established themselves in the Austrian territory, near Vienna. It appears to me, from the collection made by that celebrated naturalist in Asia Minor, in Syria, in Persia, &c. that the insects of these regions, though nearly allied to those of the south of Europe, are yet, at the same time, for the most part, specifically distinct. I have the same opinion in regard to those of southern Russia and the Crimea. The insects of the coasts of Coromandel, of Bengal, of southern China, and even of Thibet, of which some have been communicated to me by my liberal friend Mr Macleay, have many points in common with each other; but they are absolutely distinct from those of Europe, although they may be generally classed in the same genera, as well as in some of those of Africa. We do not there find any species of *Graphiptera*, *Akis*, *Scaurus*, *Pimelia*, *Lepidium*, or *Erodius*, genera of which Nature appears to have confined to the southern and westernparts of the Ancient Contine nt. Fabcius has assigned to the Eas tIndies some species of *Brachycerus*; but I have never been able to discover a single individual of that genus among the numerous collections which have been formed there. The genus *Anthia* occurs in Bengal, but further than that they do not find a single species.

The island of Madagascar, in respect to its natural families of insects, is allied in some points to Africa. But its species are very distinct, and many of them have no analogies in that country. The islands of France and Bourbon, offer also vestiges of the same affinity. The insects of these colonies appear, however, in general, to keep closer to those of the East Indies; their number is very limited.

Although the entomology of New Holland has a peculiar type, it is, nevertheless, composed in a great part, of species analogous to those of the Moluccas and the south-east of India *. The genus *Mylabris*, of which the species are so abundant in the south of Europe, in Africa, and in Asia, does not appear to pass beyond the island of Timor. If such be the case, New Holland would bear a trait of resemblance to America. In like manner, we find there the genus *Papalus*, of which the species are known more particularly to inhabit the New World. I suspect that the natural productions of that western hemisphere, considered under the relation of generic groups, are more allied to those of the east of Asia than to our own. It is known, that the Marsupial animals are confined to the eastern extremity of the Ancient Continent, and that they again appear in the New. I could produce other examples, of which some might be taken from the class of Crustaceous animals.

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* New Holland is less rich, its soil, so far as it is known, being more dry, and not so woody.

The insects of New Zealand, of New Caledonia, and probably those of the circumjacent isles, appear to me to have many affinities with the species of New Holland. I presume it is the same with some other archipelagos of the great southern ocean. These islands, chiefly composed of aggregations of coral rocks, form a chain which unites them to those of the west, and from which they have been able to receive their productions. But, on the American side, there are no groups of coral islands to afford such a mode of communication. Hence, it happens, that many of these islands are American by their geographical position, but Asiatic in regard to the animal and vegetable productions of their soil.

The New Continent presents a like progressive march in the changes of species, relative to considerable differences of latitude and longitude. M. Rose has collected in Carolina many species which are not found in Pennsylvania, and still less in the province of New-York. The researches of Abbot on the Lepidoptera of Georgia, prove, that they find there certain species of that order, of which the principal seat is in the Antilles. The banks of the river Missouri, for about twenty degrees to the west of Philadelphia, serve for the habitation of many peculiar insects, of which I owe the communication to Mr Macleay. I have also seen a collection formed at Louisiana, and have there observed other mutations. The entomology of the Antilles presents a contrast to that of the United States. The island of Trinidad, in the 10th degree of north latitude, produces equatorial species, such as the butterflies of the divisions called *Menelaus*, *Teucer*, &c., which are not to be found in St Domingo. The first named island is also characterised by the *Dasypus* or *Armadillo*, a quadruped unknown in the latter. The Brazils possess insects found equally in Cayenne; but they also produce a cloud of others which are peculiarly their own.

If we institute a comparison between the parallels of the Old and New World, with respect to the temperature suited to the various species of insects, we shall find that these parallels do not in that respect correspond. The southern insects of the western hemisphere do not extend so far to the north as in ours. Here, as we had formerly occasion to observe, they begin to appear between the 48th and 49th degrees of north latitude; while in the western world, they are scarcely found, until we reach the vicinity of 43° north latitude. The genera *Scorpio, Cicada, Mantis*, are always our guides. When one reflects on the physical constitution of America, when we consider that its soil is much irrigated, considerably mountainous, covered with great forests, and that its atmosphere is very moist, we may conceive without difficulty, that certain genera of insects of the Ancient Continent, which affect dry, sandy, and very warm situations, such as *Anthia, Pimelia, Erodius, Brachicerus*, &c. would be unable to exist on the rich, humid, shaded soil of the New World. Also the number of carnivorous coleoptera, is proportionally less on the New than the Old Continent, and their size is often inferior. The scorpions of Cayenne and of other equinoctial countries, are scarcely larger than that species of the south of Europe called *occitanus*. They are, then, far from equalling in size the African species called *Afer*, which is almost as large as our river cray-fish. But America yields not to the most fruitful countries of the ancient Continent, in regard to the species which live on vegetables, especially of the Lepidopterous order, and in the genera *Scarabæus, Chrysomela* and *Cerambyx*, &c. It is also abundant in the wasp and ant tribe; in orthopterous insects and spiders. The southern parts of China, however, and the Moluccas, appear to preserve a kind of superiority, in giving birth to such insects as the *Papilio priamus*, the *Bombyx atlas*, &c. of which the dimensions surpass those of the American Lepidoptera. One fact which I ought not to omit, is, that Europe, Africa, and Western Asia, have scarcely any insects of the genus *Phasma* or *spectres*, and those few very small; whilst those of the Moluccas and South America are of a very remarkable size. The atmospheric and habitual humidity of the New Continent, its narrow and prolonged form, the vast extent of the seas which environ it on all parts, and the nature of its soil, furnish us with an explanation of the disagreement which is to be observed between its climates and those of our hemisphere, considered under the same parallel. The New Continent is to the Ancient World, what England is to a great part of Europe. Normandy and Bretagne, compared with the provinces of France situated to their east, could also furnish us with analogous resemblances.

We have already said, that the distinction of climates given by Fabricius, was in many points arbitrary and injudicious. This we now come to confirm, by our general observations on the localities proper to the genera of Arachnides and of insects. What I wish to attempt is, if possible, to establish, with the resources of geography, divisions which may coincide with our actual zoological knowledge, and even with that which shall in future be acquired.

Greenland has been to naturalists the extreme boundary of their researches towards the Arctic Pole. From the examination which Otho Fabricius made of its insects, and which, with the Arachnides, did not exceed in number 81 species, it appears that these animals are, in whole, the same as those of Denmark, of Sweden, and more especially of that portion of Lapland which rises from the latter kingdom. One may consider the northern extremities of Greenland and Spitzbergen, that is to say, the 81st degree of north latitude, as the points where vegetation terminates. But to obviate all difficulty, and for the sake of establishing a duodecimal division, which will be convenient and frequently agree with my observations, I shall run back this last limit of vegetation three degrees higher, or to the 84th degree.

We have seen that Lapland had a special Fauna; that those of the south of Sweden, of the north of France, as far as the climate of Paris, and of a large portion of Germany, exhibited a great similitude; that the southern insects shew themselves for the first time to the south of Paris; and exactly in those places where the vine begins to prosper, by the influence of the mean temperature alone. We have said that the culture of the olive, which commences in France between the 45° and 44° of latitude, announced more particularly the domain of the species of the south; and that those of still warmer regions appear two or three degrees lower, towards the northern limits of those countries in which the orange and the palm flourish in the open air. Barbary, where the date tree comes to perfection, and where they cultivate the sugar cane, the indigo, the banana, &c. presents us with some genera of insects proper to the countries in the vicinity of the equator. Finally, we perceive ourselves to approach it still nearer, while viewing the species of the south of Egypt, Senegal,

&c. Now, if we divide by twelve degrees into twelve sections, and commence at the 84° of north latitude, a meridian which would proceed from the western parts of Spitzbergen or the neighbouring coasts of Greenland, we shall have a suite of latitudes, which will correspond successively to those of the limits of countries which we are to examine, under the general relations of Zoology and Botany. We shall continue these sections, each consisting of twelve degrees, beyond the Equator towards the Antarctic Pole, and shall stop at the 60°, under the parallel of Sandwich Land, which, on that side, may be regarded as the *ne plus ultra* of geographical discovery.

These intervals may be divided by twelve, the aliquot parts of their difference. Thus, for example, the arc comprised between the 48° and the 36° of N. Lat., lessened necessarily by some of its parts, will give the numbers 45°, 42°, 39°, of latitudes to which many of my preceding observations apply. It appears to me always certain, that a space in latitude, measured by an arc of twelve degrees, some local variations being abstracted, produces a very sensible change in the mass of the species, and that such change is almost total, if the arc is doubled to 24°, as from the north of Sweden to the north of Spain. This change takes place equally in the direction of the longitude, but in a much slower manner, and at greater intervals, since the mean temperature, without particular and modifying causes, would be uniform under the same parallel. In proportion as one advances towards the poles, the extension of the species embraces a greater number of geographical divisions, because that of the parallels of longitude diminishes progressively, on leaving the Equator. But other circumstances also tend to reduce their number.

The insects of America, even those of its northern provinces, at least as far as Canada, differ specifically from ours, whilst those of Greenland appear to be European; that last country shall be, for our geography of the insects of the Ancient Continent, the point of departure of our first meridian. It would be, on every hypothesis, intermediate between the two hemispheres. The Canaries, the Cape de Verde Islands, and Madeira, are African, by the natur of their productions. Our meridian, then, will follow a middle direction between these islands, and the most eastern cape of America, that of St Roque in Brazil. It will pass by the Western Azores, and the island of Ascension, and will come to an end a little to the west of the Sandwich Land. Its longitude will be 34° west of the meridian of Paris. According to my observations on the insects collected in Persia by Olivier, and the resemblance which they bear to those of the south of Europe, and the north of Africa, and the essential differences which may be observed in their comparison with those of the East Indies, I am induced to believe, that the greatest changes in the species take place in the south, towards the frontiers of Persia and India; and in the north, at a short distance from the eastern side of the Uralian Chain, and the Sea of Azal, a little beyond the meridian, which is under the 60° to the east of Paris. We may nearly establish this limit at 62° *, a little to the west of the Obi, of Balk and Candahar, &c., which will give us the means of continuing our duodecimal divisions; for if we add the number of 62° to that of 34°, the difference of our first meridian and that of Paris, we shall have 96, a quantity susceptible of being divided without fractions into eight parts, of which each equals the thirtieth portion of a circle. We shall thus separate the Ancient Continent into two great bands, of which one is western, the other eastern. If we give to the latter the same extent in longitude, or 96°, the meridian which will terminate it towards the east will be 158° more eastern than that of Paris. It will depart from Kamtchatka, will direct itself to the Carolinas, and from thence proceed between New Holland and New Zealand. Augmented by one-fourth, or 24°, this band will have for its eastern limit another meridian, which, at 182° to the east of Paris, will pass near the East Cape in the Straits of Behring, will prolong itself beyond the Friendly Isles, and form, without any error of importance to our object †, a line of

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* At the western declivity of the mountains which separate Mekrân and Sedjestan from Hindostan, and of those which are intermediate between the Great and the Little Bucharia, towards the sources of the Jikon and Gikon.

† It is probable that the animals of the countries which terminate the north-east of Asia, and the north-west of America, or which are adjacent to the Straits of Behring, have much in common with each other; thus these straits do not

demarcation between Asia and America. The other 144° will complete the circle of the equator, and will be the extent in longitude of the great zone proper to the insects of America. We shall divide it equally, and, under the same denominations, into two equal portions of 72° each. Thus the circle of the equator will be divided into four arcs, of which the value will be 72°, 72°, 96°, and 120°, or in the proportion of six-thirtieths, eight-thirtieths, and ten-thirtieths. The extent in longitude of the Ancient Continent will comprehend 216°, and that of the New 144°; compared with the entire measure of the Equator, they will give the following proportions: eighteen-thirtieths, twelve-thirtieths, or nine-fifteenths, six-fifteenths.

Our lesser zones or climates will be Arctic, or Antarctic, according to their position on this or the other side of the Equinoxial Line. The climate comprised between the 84° of north latitude and the 72°, will bear the name of *polar* climate. Advancing towards the Equator, and still continuing the division of twelve, we shall have the following: *sub-polar*, *superior*, *intermediate*, *super-tropical*, *tropical*, and *equatorial* climates; but as I have cut each hemisphere into two great parts, I shall distinguish the climates of each of them by the epithet of *western* of *eastern*. The Antarctic Climate shall only consist of three sorts, since we go no further than to the 60° of south latitude; those which I would call Polar and Sub-polar are those suppressed. The divisions and denominations will be the same for the two Continents. Let us make use of them by some applications to the northern and western part of our Continent, being that with which we are best acquainted.

The *polar* climate will present the insects of the greatest part of Greenland, of Iceland, and Spitzbergen. In the *sub-polar* climate we shall find those of Norway, and of the north parts of Sweden and European Russia. In these are the insects of the coldest countries. We shall place in the *superior* climate those

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form but an artificial demarcation, like that produced by those of Gibraltar, between Europe and Africa. The meridian which serves us as the limit between Asia and America, cuts in two equal parts the ocean comprised between the maritime coasts of Canton, and those of California, which are under the same latitude. It would thus form geographically a most natural division.

of Great Britain, of the south of Sweden, of the north of France, as far as the inferior course of the Loire, of Prussia, of Germany Proper, and of the south of Russia, as far as the Crimea, exclusively. The *intermediate* climate, at equal distances from the polar and equatorial, will comprehend all the other insects of the south of Europe, and of a western portion of Asia. Those from the north of Africa, to the Equator, belong to the climates which I have named *super-tropical, tropical,* and *equatorial.* These western climates may be divided, by a meridian, into two equal parts of 48° each [*]. This meridian would pass under the 14° east of Paris, near Vienna would leave to the east, the most southern part of Italy, Turkey in Europe, Egypt, &c. Now, we have already observed that many insects of the environs of Vienna, are found also in the Levant; and that those of the kingdom of Naples, of Egypt, and of the south-east of Europe, appear to differ, for the most part, from the species of the southern and western species of that division of the globe; we can then form here Sub-climates. If we cut the eastern band, of which the extent in longitude is 120°, into four equal sections of 30° each, by meridians, we shall have sub-climates, of which the boundaries accord with nature. Thus the first will comprehend Hindostan, Thibet, the Little Bucharia, Western Siberia, &c. In the second we shall find almost all the Philippine Islands, China Proper, and the regions to the north, as far as a little beyond the river Lena. The Corea, Japan, the country of the Mantcheus and the Tonguses, &c. will form the third. Lastly, the fourth will present us with Kamtschatka, and the other countries which terminate the north-east of Asia. America could also be subdivided in the same manner, or in parts of 36°.

I am sensible, that Nature, in her distribution of localities proper to the species of these animals, frequently swerves from the regular march which I have traced; that her lines of habitation form curves and sinuosities, and that they are even interrupted or crossed by others. But I have simply wished to sketch out a sort of geographical map; I have endeavoured to circumscribe it as well as possible, to divide it according to some fixed principles, into parts which were in harmony with my observations, so that the blanks or squares might be filled up, in proportion as the objects which ought to be there placed should be discovered. I have proposed to myself, in a word, to make geography accord with entomology in a general manner, not susceptible of extreme rigour. For the rest, it is, as I have already said, an attempt which has need of renewed consideration.

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[*] And afterwards of 24°.

The progressive increase in the intensity and duration of heat, has an influence on the size, the developement of the mucous membrane, and the colours of insects. In general, the nearer we approach the equinoctial regions, the more we find species remarkable for their size, the eminences and inequalities of their bodies, the brilliancy and variety of their colours. I believe I may assert, that the augmentation of light tends to convert the yellows into red or orange, and that its diminution causes them to pass into white. The same observation applies also to shells. The *Helix nemoralis*, which, in our climate, has a yellow ground or base, is red or reddish in Spain. When, in proceeding from north to south, we arrive at the island of Teneriffe, we there perceive that our cabbage-butterfly (*Papilio cheiranthi*, Hübn.), and that which we name Vulcan (*atalanta*), have experienced a modification of their colours. The diurnal butterflies of our mountains have, for the most part, the base of the wings white or brown, more or less deep.

These observations on the climates of insects, &c. interest the geographer not less than the naturalist. They may prove useful in the determination of the natural limits of some disputed countries, as in the case of islands situated between two continents, the respective distance of which may be too great to enable animals and vegetables to be propagated from the one to the other. We have seen that Greenland, which geographers join to America, is, according to the Fauna of Fabricius, more allied to Europe, or at least, that it may be regarded as a middle land, to which either continent may lay claim. Thus, the Canary Islands and Madeira, ought to be associated to Africa, for the insects found there are perfectly analogous to those of Barbary and the adjacent countries. America, also, differs under the same relations, from the western regions of our hemisphere, and we must conclude, that it has not been detached from it during the last revolution of our planet. Lastly, when I observe that the insects of the countries which surround the basins of the Mediterranean, the Black and the Caspian Seas, singularly resemble each other, as to the genera and families in which they are grouped; when I consider that the greater number of them live exclusively on a soil, sandy, usually salt, and little wooded; that the vegetables of these countries also present many points of agreement, the thought immediately rises in my mind, that such countries have drawn their origin from the waters of the ocean; but I fear lest I permit myself to be carried away, by a spirit of system. I shall only beg of geologists, to whose judgment I submit my conjectures, to permit me to give the analysis of a curious passage in Diodorus Siculus, (b. ii. art. 70,) which appears to me to preserve, under the veil of allegory, a tradition relative to the changes which these countries have undergone, which I think not inapplicable to my subject.

" The earth brought forth *Ægide*, a horrible monster, from whose throat issued a fearful quantity of flames. It appeared first in Phrygia, burned up that country, which took its name from the disaster, followed, as far as India, the chain of Mount Taurus, and reduced all its woods to ashes; then falling back upon the Mediterranean, it fired the forests of Liban, traversed Ægypt, carried its ravages as far as the western parts of Lybia, and, once more changing its direction, terminated on the Ceraunian Mountains. It desolated the country, caused a portion of the inhabitants to perish, and forced the remainder to expatriate themselves to escape death. Minerva, by her prudence and courage, slew this monster, and has since borne its skin on her breast as a defensive armour. The earth irritated by its death, gave birth to giants, which were vanquished by Jupiter, aided by Minerva, Bacchus, and other deities."

Here, as in all the mythologies of antiquity, the various agents of the power of nature are deified or personified. The action of subterranean and volcanic fire, is represented under the allegory of a frightful monster, vomiting forth torrents of fire, which travels over, successively, the mountains of Asia Minor, Armenia, Media, Hyrcania, Liban, Atlas, &c. and gaining those of Greece, terminates its desolating course on the mountains of Kimesa, in the face of Italy. Now, these are precisely the mountains where mineralogists have detected the traces of volcanoes.

Even in the time of Homer, the geographical knowledge of the Greeks, relative to the south-west of Europe, was very obscure, and it is therefore not surprising, that, at a period much more ancient, the traditions have not embraced a greater extent of country.

The calm of Nature, the repose which she accorded to these unfortunate regions, by the extinction of the devouring fires, and the re-establishment of order, were attributed to a consoling and beneficent divinity, to the wise Minerva, and such is, perhaps, the primitive origin of the consecration which the Athenians made to her of their cities.

Pardon this digression. I believed myself to have caught a glimpse of the manner in which the remembrance of the last volcanic eruptions, of which a western part of the Ancient Continent has been the theatre, was perpetuated; that it had been clothed, after the manner of all the early historical facts, under the disguise of fable; and I have therefore produced the motives of my conjectures, attaching to them no other interest than that which a search after truth inspires.

ART. X.—*Observations on the Countries of Congo and Loango, as in* 1790. By Mr MAXWELL, Author of the Letters to MUNGO PARK, &c. &c. (Continued from Vol. V. p. 275.)

BIRDS.—*Loxia, or Whidah Birds.*—THERE are vast numbers of these in Loango. They are about the size of a bullfinch, and are marked like that bird on the wings. The feathers of the tail, which is about five times the length of the body, are beautifully arched, and have a fine gloss. The Portuguese, by whom they are called *Humpasara chamada veuva*, prize them highly for their beauty, and keep them in cages in their houses, where I have often seen them.—*Boolicoco.* Some travellers have asserted, that Angola abounds with Peacocks, which are inclosed within high walls for the king's amusement, and that none of the natives dare kill them. These, I suspect, are the Boolicoco of Angoya, a very beautiful bird; but to what species it belongs, I know not. It has neither the scream of the Peacock, nor his train. It is about the size of a pheasant,—very wild,—and numerous. The name Boolicoco, is derived from its note, *coc-coc-coc.* The back and wings are of a light green,—the breast, and the large feathers of the wing, are brown,—the bill, red and yellow; the tail is long, and covered with transverse bars of green, black, and yellow; but without moons. it has, however, the crest of the peacock.—*Pigeons.* Loango can boast of a great variety of Pigeons of all colours; some are green, so that they cannot be distinguished from the leaves amongst which they conceal themselves. They are frequently so fat, as to burst when brought down by a shot.—*Mamguanza.* This bird is about the size of a turtle-dove, and of most exquisite beauty The bloom on its gorget, when distended like that of the pigeon, varies from a flaming purple to an intense blue, according to the light in which it is viewed. They are to be seen in large flocks, hovering near the fishing parties. It is, I believe, the Blue Roller of the Leverian collection.—*Pelican.* The Pelicans of Congo, which are the largest of the kind that I have seen, keep together in flocks of many thousands. They are quite unpalatable, from their rank fishy taste. I have sometimes shot them, and stuffed their skins; but owing to a superabundance of oleaginous matter, and the warm weather, they could not be preserved. The wings, when stretched, measure ten feet from tip to tip.—*Parrots.* Every morning, the Parrots leave their roosting places in large flocks, in search of food, and return in the evening. A confused noise denotes their flight. They nestle in societies on the large cotton-trees, and it was no uncommon thing to see upon one tree alone, upwards of an hundred nests. These are generally scooped out of the bark, which is very thick and easily penetrated.—*Coosu Enquela.* This is a green Parroquet not larger than a sparrow,—a very pretty bird.—*Toucan.* There is a species of Toucan in the woods, about the size of a magpie, with a monstrous protuberance upon the upper mandible. I believe it is the Ramphastos described by naturalists.—*Flamingo.* The brilliant scarlet plumage of this bird produces a beautiful effect in a flock: the length of its legs, however, gives it rather an awkward appearance on dry ground; but these, and its long neck, are absolutely necessary for procuring its food, which it searches for amongst reeds, in marshy grounds, and in pools of water. The form of the upper bill is well calculated for assisting it in this operation. When flying, the whole bird exhibits the form of a cross, whence the Spaniards and Portuguese call it the Bird of Christ, and therefore will not suffer it to be molested in their territories. The islands and sand-banks of the river are frequented by vast flocks of Flamingos, Muscovy ducks, plovers, coots, curlews, water-hens, &c.—*Owl.* Among others, there is a small Horned Owl, about the size of a canary,—a very singular little bird.—*Swallows.* Great numbers of these frequent Congo in September. They are much larger than those which visit Britain; but whether they migrate, or remain in some part of the country throughout the year, I could not ascertain.

There is a small blue bird about the size of a linnet, which, from its social habits, deserves to be mentioned. It nestles in whole flocks upon a dwarf bushy tree, and I have sometimes counted to the number of five hundred nests upon a single tree. One is apt at first sight to mistake them for fruit.

Grass-cloth.—The substance of which this is manufactured, is prepared from the inner bark of a broad-leaved plant of the bamboo species. During the intervals of leisure in the hunting and fishing seasons, great quantities of it are collected from the marshy grounds; and at the rendezvous of each party, every idle person is immediately set to work to prepare it for use before the sap exhales. When completely disengaged from the external bark, it is hung up in handfuls to dry:—part of it is afterwards stained with various substances, which produce very vivid and lasting colours. It is then worked up into cloths and different pieces of dress.

There is a small kind, chiefly used by the princes,—covered with raised work of great regularity, and surrounded with a fringed border. These are all made from the fibres before they are spun. The spinning is performed by the simple operation of twisting the fibres upon the thigh, with the hand. In this state, it is wrought into shawls and caps, and other pieces of dress.

The caps are knit with a single needle in a very ingenious manner,—commencing at the crown. They present the appearance of alternate zones of raised and inverted work, assuming different paterns. Their value varies from one to two guineas.

The shawls are generally of a circular form, with an opening in the middle to admit the head. They likewise are knit, and have a variety of open work upon them. Two small semicircular segments are left opposite to each other upon the circumference of the shawl: from each of these, a large tuft of untwisted fibres is suspended by a number of threads, wrought into the shawl alongst the margin of the segment, like radii of the circle of which it is a part. These tufts serve both for ornament and fly-flaps.

If the material, from which these articles are made, were manufactured in the same manner as flax, it might become very valuable; for it could be reduced to great fineness, the fibres being remarkably strong, and capable of very minute division.

Money.—When manufactured, grass-cloth becomes the representative of wealth: each piece is about 20 inches long and 15 broad, and worth threepence. With these, purchases of slaves, ivory, corn, pepper, &c are made; and a person going to market, takes a roll of them under his arm. A certain number sewed together, make a piece of a proportionally higher value, which at the same time serves for clothing.

Trees.—Travellers say, that Congo and Loango abound in great varieties of beautiful trees, shrubs, and flowers; but during the seasons in which I have always happened to be there, they were not conspicuous; a few scarlet flowering trees, at a distance in the forests, being all that were observable from the river. It is well known, however, that pieces of valuable cabinet timber, have at times been picked up among the fire wood, and sold in Liverpool at one guinea a foot. Bar-wood, or red Saunders, grows to a very large tree. It furnishes a valuable dye, and constitutes the chief article of trade at Mayumba, where ships of 400 or 500 tons burden come for it. The Ebony-tree abounds in Loango, and furnishes sceptres for the princes of the country. There is a species of cane, which, if cut at the proper season, would make good walking-sticks.

COTTON-TREE.—This tree grows to an enormous size. I measured two at Malemba, each 18 fathoms in circumference. The bark, which is an inch thick, yields a milky juice when wounded. The wood is so pervious, that it admits of wooden pegs being driven into it, whereby the natives are enabled to mount the tree in search of the birds which build among its branches. It is called by Europeans, the Palaver-tree, from the consultations that are held under it.

ELASTIC GUM, or *Indian Rubber*.—The tree which produces this substance is very abundant here. The gum, when first drawn from the tree, resembles cream, both in colour and consistence; and it is probably in this state that the South Americans run it upon bottle-shaped moulds. Upon exposure to the air, it quickly coagulates. The natives form it into foot-balls, which have an astonishing spring and elasticity, and are admirably adapted for that purpose.

CALABASH.—This is the shell of a species of gourd, used for holding wine and other liquors. It is sometimes beautifully ornamented with indented figures.

FRUITS.—Very few of the West India fruits are to be found either in Angoya or Chimfooka. A solitary Lime tree at Oyster Haven, is the only one I have observed; but, according to the reports of the Bushmen, pine-apples, oranges, and sugar-cane, grow luxuriantly in the interior. They have, however, fruits peculiar to the climate, which are very refreshing to seamen after long voyages. There is one called Phoote that grows in bunches like grapes, of a pleasant acid taste; also a black plum, larger than a damson, of an agreeable musky flavour.

VEGETABLES.—The chief articles of vegetable food in Congo and Loango, are plantains, Indian corn, cassava, peas, potatoes, yams, and a species of nut which is roasted for eating. These are all very abundant, and, as before mentioned, are principally cultivated and gathered by the women. The plantain and cassava are of very rapid growth, and extremely productive. Their peas, called by the French the Angola pea, grow upon a tall shrub, not unlike the laburnum, six or seven feet high, and though rather a more flatulent food than the common pea, are very agreeable and well tasted. They have also a pleasant odoriferous pepper, with which, along with Cayenne, they season their meats. Cotton, Cayenne pepper, and Palma Christi (the shrub from which castor-oil is extracted), grow spontaneously, and may be collected in any quantity.

MINERALS.—Of these I can say nothing, having been at no pains to collect specimens; but if we may judge from the pompous names of Mountains of the Sun, and Mountains of Crystal, given by travellers to some of the high ranges of land, a great variety of these might be obtained. At Malemba, the natives brought me a cubical piece of blue shining ore: it was heavy, and not unlike lead-ore; but on examining it a month afterwards, I found that the action of the air had reduced it to a grey powder, which makes me suppose it was manganese. Some of the rocks in the Congo have a greenish cast, resembling pyrites.

SCENERY.—The whole of the coast between Mayumba in 3° 30′, and Benguela Nova in 12° 30′ south latitude, affords the most delightful prospect from the sea that can be imagined. Perpendicular red cliffs in many places skirt the shore, while the back ground consists of mountains, here, receding far inland, there, approaching the sea. Several of these mountains are crowned with lofty semicircular precipices, set, as it were, in fringes of trees and shrubs; one of these to the southward of Benguela, from its resemblance to a hat, has been called Hat hill by voyagers. In other parts, they are studded with pinnacles of single rock, like monuments of Roman or Egyptian grandeur. On the summit of a high hill seen from Embomma, there is a rock of this description, called by the natives, Soanna. Another hill to leeward of Ambrize, has a rock of prodigious length and bulk lying across its summit. The intermediate space between the ridge of mountains and the sea, is beautifully diversified with rising grounds, and ornamented with clumps of lofty trees. The effect of the whole is magnificent, and has no doubt led the Portuguese to apply the names of many of their most romantic and picturesque scenes in Portugal, such as the Cascais, &c., to certain views of this fairy landscape. Immense lawns and pasture-grounds compose the greatest part of the fore ground:

LONG GRASS.—To all appearance, when seen from a distance, the grass would not afford concealment to a rabbit, but in reality, it is so long as to hide an elephant, being in many places 12 feet long. Even on the hills, where the soil is shallow, it rises five or six feet in height. The footpaths formed by the natives, wind through it in the most intricate and perplexing manner, and cannot be traversed but with considerable danger, owing to the concealment and opportunity afforded to all the hostile tribes of these regions. To guard against attacks when travelling under night, the natives carry blazing torches made of plantain leaves, besmeared with an odoriferous resin. From this resin, a druggist in Liverpool extracted an essential oil which he sold for nutmeg-oil!

CONFLAGRATIONS.—The great risk and inconvenience of travelling through the long grass being much felt, the natives never fail to burn it in September or October when completely dry and withered. A voyage to the coast at this season, were it only to behold the waving lines of fire, would be amply repaid. I had the good fortune to witness a scene of this kind at Embomma, where the hills rise more abruptly from the plain than they do upon the sea coast. Being in the night time, it produced an effect, not only sublime, but terrific. When the flames reached the hills, two miles from the ship, they cast so great a light, that it was possible to read on board. The fire raged in a continuous blaze fully six miles in length, producing a noise somewhat like distant thunder; and from the Alpine nature of the ground, assuming a variety of singular shapes and extraordinary forms.

I cannot but think, that the little hamlets and villages must frequently suffer on these occasions, unless that the inhabitants take special care to have a sufficient space clear of grass around their dwellings; and even then, the combustible materials of which they are built, leave them at the mercy of every falling spark. It may be remarked here, how liable they must always be, on that account, to accidents from fire.

For a week or ten days after the conflagration has passed over the face of the country, nothing can be conceived more dismal and waste; but the luxuriant verdure which rapidly advances in the beginning of November when the moist weather sets in, quickly effaces every vestige of fire, and makes ample amends for the few days in which blackness and desolation kept joint possession of the earth. To these annual conflagrations, and to the effects of the ashes on the soil, must be ascribed the civilized and cultivated appearance of the country. This is the harvest of the carrion-crow, the kite, and the vulture, which keep hovering in the rear of the flames, pouncing down upon snakes, lizards, crabs, &c. destroyed by the fire; and, as already mentioned, the Boa Constrictor itself, which fears no other enemy, frequently falls a victim to the fury of this irresistible foe, and becomes the prey of these rapacious birds.

(To be continued.)

ART. XI.—*Observations on the Difference of Level of the East and West Seas.* By JOHN ROBISON, Esq. F. R. S. E. In a Letter to Dr BREWSTER.

DEAR SIR,

ON looking over some old numbers of Thomson's Annals, my curiosity was excited by the statements which appear in the following extracts.

In the number for September 1816, p. 163. Dr Thomson, speaking of Birmingham, says: "Its elevation has been well "ascertained, by means of the numerous canals which proceed "from it in all directions, and afford a level both to the east and "west coast. It must be observed, however, that the height "above the level of the sea, as determined by canal-locks, is "not to be implicitly depended on; for, according to the data "furnished by the canals, the Irish Sea is 50 feet above the Ger-"man Ocean; but 50 feet is certainly far beyond the truth *."

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* In the same page there occurs this passage: "Barbeacon, a conspicuous "spot about eight miles north of Birmingham, is 750 feet above the level of the "Thames at Brentford. Mr Creighton determined its height above Birmingham "by levelling; he found the height, as given by the authors of the Trigonometrical "Survey, deviates no less than 150 feet from the truth." The well known scrupulous accuracy of the operations of the survey, and the talents of Mr Creighton, make it likely that there is some misapprehension in this statement.

Again, in the Number for November 1816, p. 392. "The "difference between the height of the sea on the east and west "coasts of Britain is 50 feet."

In the Number for March 1817, p. 177. Mr Galton, F. R. S. in a paper on canal levels, says, "in connecting these sections, "I observed with some surprise, that the Thames at Brentford "appeared to be fourteen feet lower than the junction of the "Duke of Bridgewater's canal with the Mersey at Runcorn."

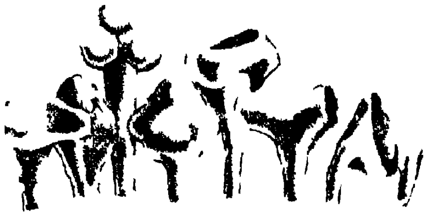
The discrepancy of these statements,—the obvious impossibility of the one, and the improbability of the other, made me desirous of ascertaining the point of fact, where the two seas approach so nearly as in the Friths of Forth and Clyde. For this purpose, I instructed the superintendants of the east and west districts of the Forth and Clyde Canal, (on three particular days), to take notes of the rise and fall of the tides at their respective ends. I at the same time took measures for ascertaining the actual difference of level of every lock, when full and when empty. I take the liberty of sending you the results, in the hope that some of your readers, who may possess information regarding the slope of the surfaces of the two friths, may communicate what may be necessary to complete the connection of level to the open ocean on either side. When the Caledonian Canal shall have been completed, it would be satisfactory to have a similar set of levels from the Linnhe Loch to the Beauly Frith.

Observations at Bowling Bay on the Clyde:

1821.			Feet. In.		Feet. In.	
Oct. 13.	A calm day,	High Water,	152.1,	Low Water,	159.8¼	below summit-level.
Nov. 1.	Strong breeze from W.	Do.	150,	do.	157.10¾	do.
Nov. 3.	Nearly calm, with considerable flood in the river,	Do.	153.10½	do.	157.2¼	do.

The Superintendant considers the tides of 1st and 3d November to be irregular, and that of the 13th October to be a fair average one.

PLATE III



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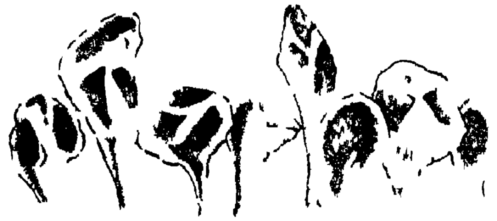

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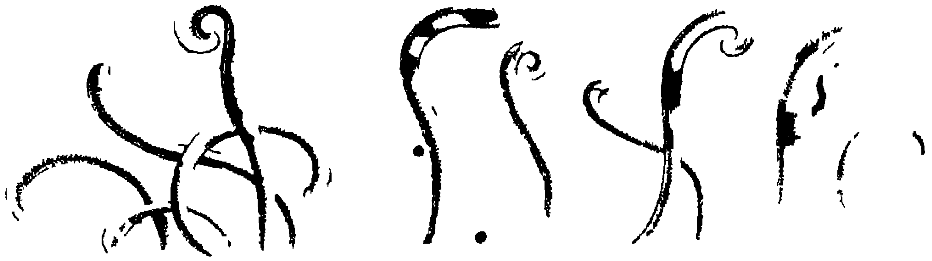

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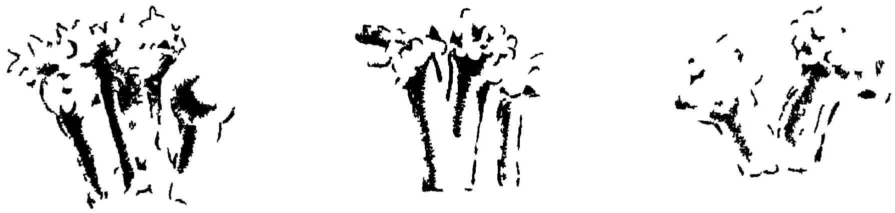

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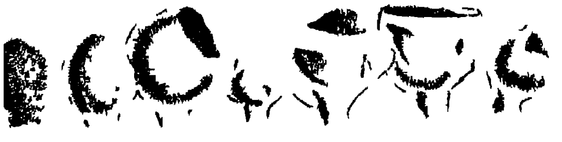

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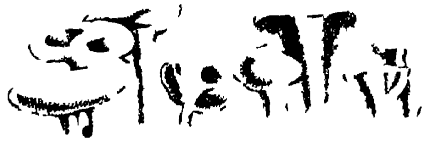

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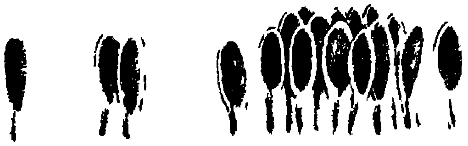

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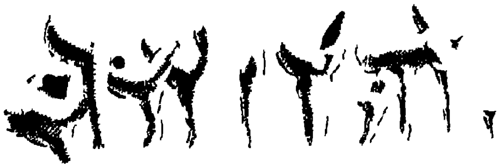

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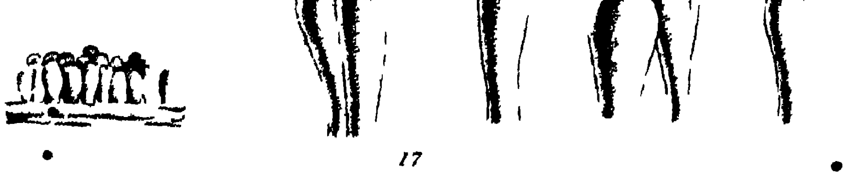

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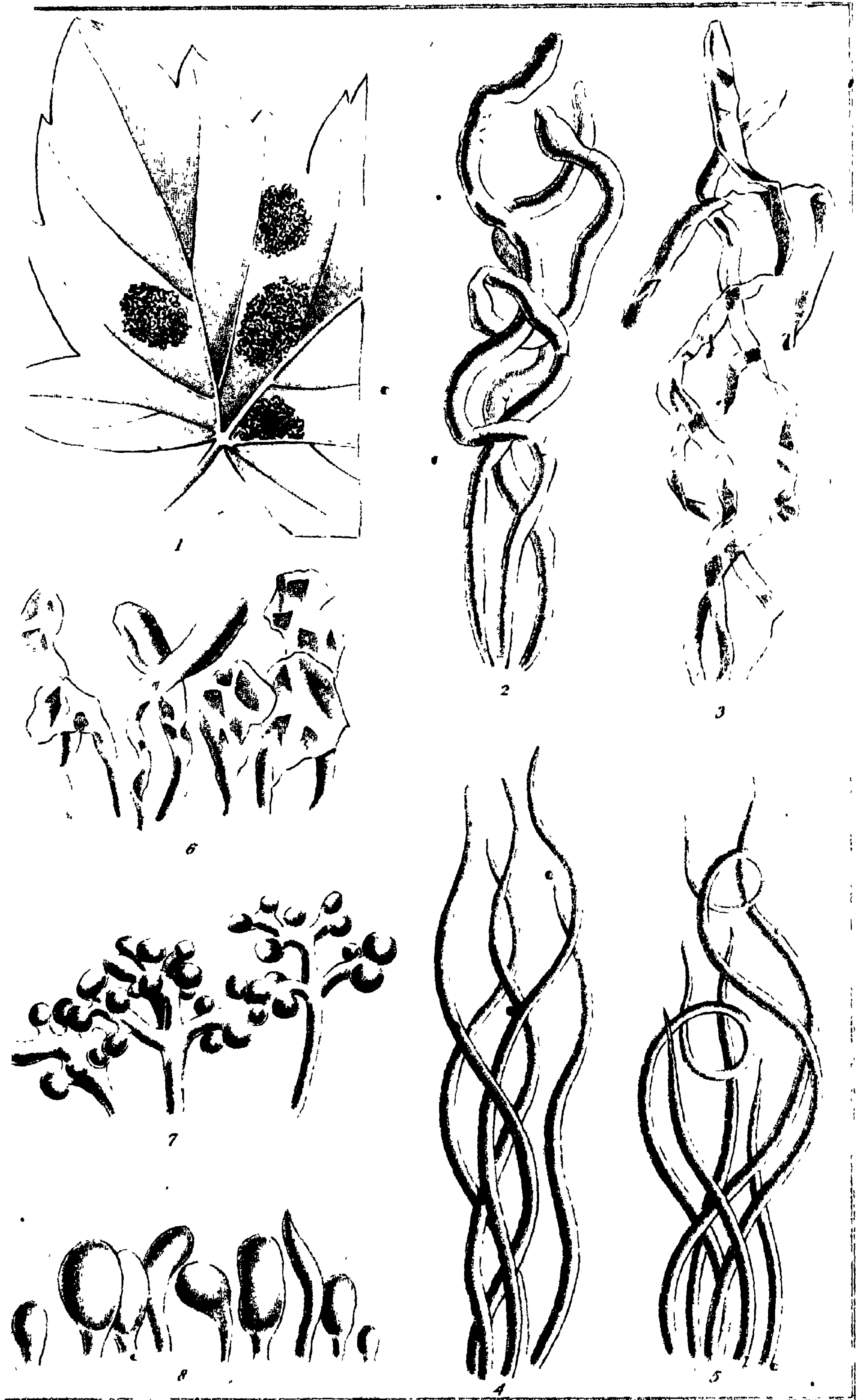
Del^t

Eng^d by W H Lizars

Published by A Constable & C° Edin^r 1821

PLATE II.

Edin.r Phil. Jour. Vol. IV. P. 71



reville del.t
Eng.d by W. H. Lizars

Published by A. Constable & C.o Edin.r 1821.

Observations at Grangemouth on the Frith of Forth:

1821.			Feet. In.		Feet. In.	
Oct. 13.		High Water,	[illegible]	Low Water.	162.6	below summit level.
Nov. 1.	A gale from W.	do.	[illegible]	do.	not specified.	do.
Nov. 3.	Fresh breeze from S.	do.	[illegible]	do.	do.	do.

The Superintendant of this district considers the tide of the 13th October to be nearly two feet higher than the average, and those of November to be much lower.

From all I can learn from the persons employed about the two extremities of the Canal, I infer that the descent on the west end from the summit-level to average half tide, is 155.10, and that the descent at the east end is somewhere between 154 and 155 feet.

I may here notice that the effect of wind in altering the level of the surface of water, is strongly exemplified in the reach which forms the summit-level of the Forth and Clyde Canal. This reach is about eighteen miles long, nearly in a straight line east and west. When a westerly gale has blown for some time, the action of the wind sweeps away the water from the west end, sinking its surface, and accumulating it at the east end, where it escapes over the lock-gates in a stream sometimes ten inches deep.

The observations of the tides at either end of the Canal are to be continued for some time, and if I should find that the average differs from what is taken above, I shall communicate the result. I am, dear Sir, yours very truly,

JOHN ROBISON

ART. XII.—*A Monograph of the Genus* ERINEUM. By ROBERT KAYE GREVILLE, Esq. F. R. S. E. M. W. S. &c. Communicated by the Author.

THE genus Erineum is so distinct from all other known genera of fungi, that none can possibly be confounded with it. At the same time, it would be extremely difficult to give a satisfactory account of its physiological structure. Our knowledge of these minute plants is at present so limited, that even to attempt to describe it would be imprudent. I shall therefore touch upon nothing which is not clearly perceptible with the aid of a good microscope.

This fungus is found only upon living leaves, on the under or upper surface of which, it forms rather broad and much depressed tufts, of various colours, sometimes in the form of distinct spots, or so running together, as to cover a great part of the leaf. These patches, under the microscope, appear to consist of a great number of short filaments, or rather tubes, of a subrigid, diaphanous, and somewhat succulent aspect, of various forms, cylindrical, turbinate, subulate, clavate, &c. and often truncate at the summit. These tubes in some species seem to contain sporules in great abundance, as in E. *aureum;* but in others they are entirely wanting. Their nourishment appears to be derived from the juices of the parent-leaf, from the check they receive when the leaf is plucked before they are mature. Many species require some weeks to attain their full growth; and in some, as E. *acerinum*, there is a succession during the greater part of the summer.

Erineum is situated in the sixth and last Class (GYMNOCARPI) of Persoon's System of Fungi, betwixt the genera *Dematium* and *Racodium.* The character of the former is, *Byssi cæspitosi aut effusi, fila lævia;* that of the latter, *Byssus subcompacta, pannum referens.*

In the Synopsis Fl. Gall. by Lamarck and De Candolle, *Erineum* is nearly at the end of the first division (*fungi filamentosi*) of the first *Tribe* (GYMNOCARPII), and connected with the genera *Conoplea* and *Stilbum.*

In the more recent work of Nees von Esenbeck, *Erineum* is found with *Rubigo* (Link), under a sub-section, entitled *Byssi parasitici*, of which they form the only genera. *Rubigo*, in my opinion, cannot, on any reasonable grounds, be kept separate from *Erineum.* I have, therefore, along with most other botanists, continued to consider them as the same.

None of the species of *Erineum* have hitherto been found on herbaceous plants *: indeed, so completely are they confined to trees, that the vine is the only exception at present known. Among them, therefore, are we to look for new species; and the American botanist would find his labour amply repaid by an attentive search through his varied and splendid forests. In our own country, several known species of this genus remain to be detected, and, in all probability, many new ones. Our native botanists may rest assured, that, from the shortness of the period which has elapsed since the study of the minute fungi has been prosecuted in this island, no conjecture can be formed as to the extent of its riches.

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* *Erineum articulatum*, Syn. Fl. Gall. p. 15. said to grow on the dead stems of herbaceous plants, is *Dematium articulatum* of Persoon; so entirely does it differ from Erineum, that it is surprising how it has been admitted into that genus.

The only Orders, on plants of which, species of Erineum have been found, are, AMENTACEÆ, ROSACEÆ (POMACEÆ), NUCULACEÆ, TILIACEÆ, SARMENTACEÆ, and ACERACEÆ. Of these the first contains trees the most favourable to the production of *Erineum.*

ERINEUM, *Link.*

Fungus epiphyllus depressus sub-grumosus vel sericeus. Tubi cylindrici clavati aut turbinati, simplices vel compositi, in cæspitulum congesti [†].—*Gr.*

* *Cæspituli grumosi.*

ERINEUM *acerinum*, Pers.

Plate II. Fig. 6.

E. hypophyllum depressum maculæforme vel confluens rufo-fuscum, tubis inclinatis flaccidis clavatis rarè turbinatis.—*Gr.*

Erineum acerinum, *Pers.* Syn. Fung. p. 700.
De Cand. Fl. Franc. tom. ii. p. 73.—Syn. Fl. Gall. p. 15.
Albert et Schw. Conspect. Fung. p. 370.
Moug. et Nest. Stirp. Cryptog. 198.
Hook. Fl. Scot. Pt. II. p. 34.
Mucor ferrugineus, *Bull.* t. 514. p. 12.

Hab. In foliis Aceris pseudo-platani; vere, æstate, autumno.

White, pale pink or yellowish, in its young state, changing frequently into rose-red, and finally into a deep fulvous colour. The spots or tufts are dense, depressed, very irregular in form, and often so confluent as to cover a great part of the leaf. Filaments, or rather tubes, glistening under a pocket lens, and bent at an obtuse angle. Under a high power they are clavate, flaccid and diaphanous, marked occasionally with irregular transverse or oblique lines. This is one of our most frequent species, and begins to form on the inferior surface of the leaves, soon after the tree is in full foliage.

[†] Persoon, in his *Traité sur les Champignons comestibles*, has a few observations on this genus, which he considers among *les moisissures*, very unjustly I think; for, though it may come next to them in a system, it does not by any means follow that it is produced by the same cause, or under the same circumstances. He also mentions the necessity of dividing Erineum into two or three genera; but, from the species at present known, I do not perceive how he can find sufficiently natural

At Roslin and Braid Hermitage, it is very luxuriant and abundant.

ERINEUM *tortuosum*, mihi.

Plate II. Fig. 2.

E. hypo- et epiphyllum maculæforme irregulare albo-ferrugineum, tubis linearibus cylindricis tortuosis apicibus rotundatis.

Hab. In foliis Betulæ albæ; vere et æstate.

A beautiful species, white in its young state, and pale or unequally ferruginous when old. Spots irregular, occasionally on the upper as well as the under surface, somewhat tufted, and in a slight degree immersed. Tubes, under the microscope, long and entangled, linear, flexible, cylindrical, diaphanous, rarely incrassated at the apex. This species seems to prefer the young and luxuriant leaves which are found in shady situations, on the lower branches of young birch trees. It occurs in spring, and early in the summer; and grows at Ravelrig Toll, near Currie, among the salices; and at Bilston Burn, both in the neighbourhood of Edinburgh.

ERINEUM *tiliaceum*, Pers.

Plate III. Fig. 3.

E. hypo- et epiphyllum pallidum cæspituli sæpe confluentes, tubis linearibus gracilibus apicibus incurvatis.—*Gr.*

Erineum tiliaceum, *Pers.* Syn. Fung. p. 700.
De Cand. Fl. Franc. tom. ii. p. 74.—Syn. Fl. Gall. p. 15.
Albert et Schw. p. 370.
Moug. et Nest. No. 98.
Nees von Esenb. p. 64. t. 5. f. 62.

Hab. In foliis Tiliæ europeæ; æstate.

Always of a pale colour, but in age somewhat yellowish, very

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and distinctive characters. It ought always to be remembered, that, in plants so minute as those under consideration, the microscope can alone be trusted in tracing true generic and specific characters. Two plants, whose aspects differ considerably before the naked eye, may agree, when magnified, and cannot therefore be separated.

slightly immersed, and rather tufted. Spots or tufts roundish, sometimes confluent. Tubes linear, slender, somewhat rigid, sub-cylindrical, bent, with the apex incurved, and rarely sub-incrassated; in some of the tubes are occasionally appearances of septa, but their existence is very doubtful. There can be no doubt of this being a true *Erineum*, although, as De Candolle observes, it may be less understood than its congeners. In the summer months, this species is not uncommon on the Continent, but in this country it has not yet been discovered.

ERINEUM *vitis*, Schrad.

Plate II. Fig. 3.

E. hypophyllum cæspitosum gregarium sub-confluens, rubiginosum vel fuscum, tubis longis linearibus intricatis flaccidis.—*Gr.*

Erineum vitis, *Schrad.* ex Schleich. Crypt. Exsic. No. 100.
De Cand. Fl. Franc. tom. ii. p. 74.—Syn. Fl. Gall. p. 15.
Moug. et Nest. No. 199

Hab. In foliis Vitis viniferæ; æstate.

At first whitish, afterwards pink, lastly reddish and sub-ferruginous. Spots, numerous, tufted, roundish, or sub-angular, sometimes confluent. Tubes, very long, linear, flexuose, having often a geniculated appearance, flaccid, weak, apex rounded. A fine species, confined to the inferior surface of the leaf, and tolerably abundant on the Continent during the summer months.

ERINEUM *subulatum*, mihi.

Plate II. Fig. 4.

E. hypophyllum latiusculum sub-quadratum tomentosum pallidum, tubis sub-rectis longè attenuatis.

Hab. In foliis Juglandis regiæ; æstate.

A white plush-like down is the first appearance of this plant, which, as it advances to maturity, becomes sub-tomentose, and of a pinkish or dirty-white hue. Tubes, long, cylindrical, diaphanous, sub-erect, and gradually attenuated. The veins of the leaf, at that part where the plant is situated, are considerably thickened, which gives it a solid and dense aspect, and, from being confined betwixt the parallel lateral veins, it has in general the figure of an oblong square. This species is rather unfrequent: it has been found in France, but not published; and last summer I met with it on a walnut-tree, close to the house, at Braid Hermitage, near Edinburgh.

Erineum *ilicinum*, De Cand.

Plate II. Fig. 5.

E. hypophyllum tomentosum confluens rufo-aurantiacum, tubis longis linearibus flexuosis attenuatis.—*Gr.*

Erineum ilicinum, *De Cand.* Syn. Fl. Gall. p. 15.

Hab. In foliis Quercus ilicis, rariùs *.

Changing from a yellowish to a rich orange-brown; tomentose, tufted, generally confluent, and preferring the margin of the leaf, which is frequently rolled in so as partly to conceal the plant. Tubes, long, flexuose, linear, atenuated and acute. They have sometimes the appearance of being irregularly divided by oblique lines, the nature of which I have not been able to ascertain. This is a very handsome and rare species, and only described, I believe, in the *Syn. Fl. Gall.* It grows only on the lower surface of the leaf, and is in perfection in summer.

Erineum *clandestinum*, mihi

Plate II. Fig. 8.

E. hypophyllum albo-roseum confluens margine folii involuta obtectum, rarè maculæforme, tubis brevibus ovatis sub-capitatis vel clavatis.

Hab. In foliis Cratægi oxyacanthæ; æstate.

Changing from white or pale pink to an unequal ferruginous colour, which is darkest when the plant happens to occur in the form of spots, in the centre of the leaf; it is in general confined to the margin, which is so completely rolled in, as to entirely conceal the plant. This is probably the reason why it has been so long overlooked; to the eye even of a nice observer, it might pass as a receptacle of insects. The tubes are short, very simple, and often tinged with yellow. In spring and summer it is not unfrequent, particularly at Roslin, by the river side beneath the Castle, and in similar situations.

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* The possession of this very rare species, with two others not hitherto described, I owe to the kindness of my acute botanical friend G. A. Walker Arnott, Esq. who received them in Paris from the Herbarium of the Baron Delessert, and divided them with me.

Erineum *alneum*, Pers.

Plate II. Fig. 7.

E. hypophyllum inæqualiter maculosum vel effusum albo ad fulvo ferrugineum, tubis ramosis capitatis sub-racemosis.—*Gr.*

Erineum alneum, *Pers.* Syn. Fung. p. 701.
De Cand. Fl. Franc. tom. ii. p. 593. Syn. Fl. Gall. p. 15.
Albert. et Schw. p. 371.
Moug. et Nest. No. 99.
Hook. Fl. Scot. Pt. ii. p. 34.
Rubigo alnea, *Nees von Esenb.* p. 64. t. 5. f. 63. *B.*

Hab. In foliis Alni glutinosæ: æstate.

Colour white or pinkish in young plants, and changing in maturity and age to yellow-ferruginous or deep fulvous *. Spots or tufts very irregular, often so confluent as to nearly cover the inferior surface of the leaf, robust, grumous, sub-immersed, which is ascertained by examining the upper surface of the leaf, rather than by the aspect of the plant. Tubes very beautiful, and unlike those of any other known species, dividing towards the summit into two, three, or four sub-patent, short branches, as thick as the rest of the tube, and each clustered with several globular, sessile heads, or perhaps more properly *lobes*. This species, which is far from being of frequent occurrence, is at maturity in the summer months. The only spot in which I have found it in this country, is by the river side half way between Lasswade and Roslin.

Erineum *betulæ*, De Cand.

Plate III. Fig. 1.

E. epi- rarè hypophyllum late inæqualiter effusum sanguineum, tubis multiformibus turbinatis, clavatis vel capitatis, apicibus sæpe truncatis.—*Gr.*

Erineum betulæ, *De Cand.* Syn. Fl. Gall. p. 15.
Albert. et Schw. p. 370. (excl. char. "*rufo-fuscum*," qui ad E. betulinum pertinet.)

Hab. In foliis Betulæ albæ; vere et æstate.

This elegant species is so remarkable on account of its splendid sanguineous or purple colour, that it must attract the attention of the most careless observer. Another species, however, seems to have been confounded with it by Albertini and

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* Dr Hooker has mistaken the colour of this plant in calling it nearly scarlet.

Schweiniz, in their excellent *Conspectus Fungorum*. A part of their character only belongs to the plant in question, as well as a portion only of the description. The other species is also peculiar to the birch, and hence the error of conceiving the two species to be different states of one plant. *E. betulæ* is almost invariably found on the superior surface of the leaf, is of a deep blood-red colour, and very irregular in form; sometimes almost covering the leaf, at other times so spotted and scattered, that it has the appearance of having been dashed on by accident. The colour becomes dingy in old age, but does not change as the above named authors suppose. Viewed with a pocket lens, the plant appears finely granulated, and the tubes under a high power various in figure, turbinate, capitate, and often hammer-shaped, with the summits truncated. So intense is the colour, that the tubes, under the highest power of a compound microscope, retain a considerable portion.

Erineum *betulinum* has its spots or tufts mostly on the *under* surface, and the colour changes from *white* to a dark ferruginous, or even tobacco colour. The tubes have some resemblance in their form, but are smaller and more eccentric. The whole plant also is never so confluent as the other, nor is it so completely emersed. E. *betulæ* seems to prefer those leaves which have been some time expanded and more exposed to the sun, while the other is fond of shade and younger leaves.

Summer is the best season for finding this splendid Erineum, and it is by no means uncommon. At Ravelrig toll, near Edinburgh, I have noticed it three successive seasons.

ERINEUM *populinum*, Pers.

Plate III. Fig. 4.

E. hypophyllum maculæforme immersum rufescens, tubis deformibus congregatis crassis sub-ramosis apicibus irregularibus erosis.—*Gr.*

Erineum populinum, *Pers.* Syn. Fung. p. 700.
De Cand. Syn. Fl. Gall. p. 15.
Albert. et Schw. p. 371.
Moug. et Nest. No. 100.

Hab. In foliis Populi tremulæ; æstate.

A singular species, changing from a purplish to a rich dark brownish-red colour. Spots distinct, entirely immersed, roundish, rough. Tubes much clustered together, sub-branched or lobed, summits rugged and deformed, of a pale pink colour under a strong power of the microscope. This plant is well marked, and cannot be mistaken for any other species. It is confined to the under side of the leaf, and met with during the summer months in perfection. Of this island it has not yet been found a native.

ERINEUM *betulinum*, Rebent.

Plate III. Fig. 8.

E hypo- rarè epiphyllum fulvo-ferrugineum sæpe confluens, tubis brevibus variantibus plerumque sub-bicornibus aliquando turbinatis.—*Gr.*

Erineum betulinum, *Rebent.* Prod. Fl. Neomarch.
Albert. et Schw. p. 370. *(excl. part)* vid E. betulæ.
Moug. et Nest. No. 200.

Hab. In foliis Betulæ albæ; vere et æstate.

Changes, as it advances to maturity, from white to ferruginous, and lastly to a dark tobacco colour. Spots or tufts irregular, slightly immersed, sometimes confluent, on both surfaces of the leaf, but chiefly the under. Tubes dwarfish, very eccentric in their form, capitate or turbinate, but more frequently dividing at the top into two blunt, short, divaricate, horn-like terminations. This plant has been mistaken by Albertini and Schwieniz for an old state of E. *betulæ*. Vid. what I have said under that species. I do not possess the *Prod. Fl. Neomarchicæ*, and the only proof I have of this plant being described in that work, are the specimens published in that valuable collection the *Stirpes Cryptogamæ* of Mougeot and Nestler, No. 200. As these plants, however, have never been subjected to rigorous microscopical investigation, it is very possible that my E. *tortuosum* should have been confounded with the species in question, as both it and also E. *betulæ*, are found on the leaves of the same tree. In spring and summer, this plant may be found in shady and moist places: my specimens were collected at Roslin.

Erineum *fagineum*, Pers.

Plate III. Fig. 2.

E. hypophyllum depressum maculæforme aut sub-confluens rubiginosum vel rufo-fuscum, tubis rotundato-turbinatis apicibus truncatis rarè clavatis.—*Gr.*

Erineum fagineum, *Pers.* Syn. Fung. p. 700.
De Cand. Fl. Franc. tom. ii. p. 592. Syn. Fl. Gall. p. 15.
Albert. et Schw. p. 370.
Moug. et Nest. No. 97.
Rubigo faginea, *Nees von Esenb.* Syst. der Pil. et Schw. p. 64. t. 5. f. 63. *a.*

Hab. In foliis fagineis; æstate.

Depressed, minute, pale when young, afterwards dark reddish. Spots oblong, often confluent. Tubes somewhat variable in shape, but generally much rounded, with truncated summits. It has not yet been discovered in Great Britain, but is most probably a native. A variety of it is said to grow upon the purple beech, particularly in Switzerland. It should be gathered in summer.

Erineum *curtum*, mihi.

Plate III. Fig. 5.

E. hypophyllum maculæforme irregulare rubiginosum, tubis ovatis vel sub-orbiculatis truncatis.

Hab. In foliis Aceris platanoidis; vere, æstate, autumno.

Colour rich, dark, reddish. Spots usually distinct, irregular in figure, depressed. Tubes minute, very short, sub-orbicular, apex generally truncate. Albertini and Schweiniz have committed an error in identifying this species with that which grows upon *Acer pseudo-plantanus*, as no two species can be more distinct. This is another instance of the necessity of microscopical accuracy. E. *curtum* is extremely rich and beautiful, and confined to the inferior surface of the leaf. Like E. *acerinum*, it may be gathered during the greater part of the year. It is a native of France, Germany, and Switzerland.

Erineum *agariciformis*, mihi.

Plate III. Fig. 4.

E. hypophyllum planum latiusculum sub-effusum sordidè rubiginosum, tubis brevibus capitatis turbinatis truncatis.

Hab. In foliis Aceris campestris; æstate.

Colour pale or yellowish in its young state, changing in maturity to a pinkish red. Spots depressed, irregular, broad, often very confluent, and less dense at their edges. Tubes remarkably turbinate and mushroom-shaped, varying sometimes to cuneiform. This plant differs entirely from E. *acerinum*, with which De Candolle, in the *Fl. Franc.*, has confounded it. At present it is not known in Great Britain even as a variety. It is found on the under surface of the leaf, and remains as long probably in perfection as the preceding.

** *Cæspituli vel maculæ sericiæ.*

ERINEUM *aureum*, Pers.

Plate III. Fig. 7.

E. hypo- rarè epiphyllum sericeum aureum late effusum, tubis flavis simplicibus minutissimis clavatis.—*Gr*.

Erineum aureum, *Pers.* Syn. Fung. p. 700.
De Cand. Syn. Fl. Gall. p. 15.
Albert. et Schw. p. 371.

Hab. In foliis Populi nigræ; æstate.

Of a splendid gold colour, becoming dingy in old age. When in distinct spots, immersed; when widely effused, so as to cover nearly the whole inferior surface, which is sometimes the case, the leaf is collapsed more or less, and has, at first sight, the appearance of having been the residence of an *aphis*. It rarely appears on the upper surface, and then only in small spots. The tubes are so minute, that they require a powerful microscope, but are then very distinctly seen, from their fine yellow colour; the yellow portion seems to be enclosed within a pellucid covering, and probably consists of a mass of sporules, which are evidently very numerous, and appear to escape by an aperture at the apex.

I gathered this plant during the last summer very abundantly at Carlowrie near Edinburgh, and in the neighbourhood of Glasgow.

ERINEUM *minutissimum*, mihi.

Plate III. Fig. 1.

E. hypophyllum pallido-sordido-purpureum sericeum late effusum, tubis simplicibus minutissimis rotundato-clavatis.

Hab. In foliis Quercûs roboris, vere et æstate.

A very inconspicuous plant, unless the eye of the botanist is accustomed to similar objects. It appears at first in the form of a faint blush, or slight change of colour, on the under surface of the leaf; this grows gradually darker till it has become of a pale reddish obscure purple, and of a minute sericeous or velvety aspect. It forms large oval or irregular patches, and is most easily detected by the leaf being more or less swollen or distorted. The tubes are very small, even under a high power, simple, and roundly clavate. It is a rare species, and occurs in spring and summer in the woods at Roslin, and similar situations.

I have to regret that one described species is wanting to complete this short monograph, but from its excessive rarity, I have not been able to procure a specimen. It is *Erineum pyrinum*, Pers. Disp. Fung. p. 43. t. 4. f. 2.

E. *oblongum laxum spadiceum* is the only character given in his Synopsis.

Albertini and Schweiniz add to the above distinction, *Planum nec congestum fila laxa congesta;* and conclude with *Rarissimum item unica solum vice inventum in pomario domestico ad folia Pyri Mali, exeunte Junio.*

EDINBURGH, *Nov.* 15. 1821.

Explanation of the Plates.

Plate II. Fig. 1. *Erineum acerinum*, natural size.
2. Tubes of E. *tortuosum*, very highly magnified.
3. Do. of E. *vitis*, do. do.
4. Do. of E. *subulatum*, do. do.
5. Do. of E. *ilicinum*, do. do.
6. Do. of E. *acerinum*, do. do.
7. Do. of E. *alneum*, do. do.
8. Do. of E. *clandestinum*, do. do.

Plate III. Fig. 1. Tubes of E. *betulæ*, very highly magnified.
2. Do. of E. *fagineum*, do. do.
3. Do. of E. *tiliaceum*, do. do.
4. Do. of E. *populinum*, do. do.
5. Do. of E. *curtum*, do. do.
6. Do. of E. *agariciforme*, do. do.
7. Do. of E. *aureum*, do. do.
8. Do. of E. *betulinum*, do. do.
9. Do. of E. *minutissimum*, do. do.

ART. XIII.—*Account of Electro-Magnetic Experiments made by* MM. VAN BEEK, Professor VAN REES *of Liege, and* Professor MOLL *of Utrecht.* In a Letter to Dr BREWSTER.

DEAR SIR,

THE following electro-magnetic experiments may perhaps not be unacceptable to you. They were made jointly with my friend Mr Van Beek of this city, and Professor Van Rees of the University of Liege. Whatever may be good in them, must be almost entirely attributed to the ingenuity of Mr Van Beek, who had the principal share in devising and fitting up the apparatus.

The electrical machine employed consisted of two plates of 70 centimetres in diameter. The battery was composed of seven Leyden phials, the coating of which contained 5962 square centimetres. We employed steel needles of 7½ centimetres in length, as free from magnetism as they could be obtained. We had a sensible magnetic needle of five centimetres long, to explore the magnetism communicated by electricity to the other needles.

1. Round a glass-tube was twisted a brass-wire, so as to form spiral windings, turning to the right-hand side. A steel-needle was put in the glass-tube. The battery was discharged through the spiral wire, and the needle was found magnetic, having its north pole turned against the negative part of the spiral wire.

2. The same experiment being repeated, with this difference, that the spiral was twisted round the glass-tube to the left hand, the needle became magnetic, but its north pole turned towards the positive side of the spiral wire.

It must be observed, that we call the *north pole of the needle*, that which directs itself to the north, when the needle is freely suspended.

3. A steel-wire, 64 centimetres in length, was put in a glass-tube. Round this tube was twisted a spiral brass-wire, the turns alternately from right to left, then from left to right, again to the left, and so on, alternating eight times on the length of the tube. The wire and tube were externally covered with sealing-wax, to prevent the electric spark crossing from one winding of the spiral to the next, the electric discharge being sent through the spiral, and the steel being taken out, had as many different

poles *(points conséquens)* as the turns of the spirals changed their direction.

4. A brass spiral wire was used as in the 1st and 2d experiments; but instead of placing the needle in a glass-tube, within the windings of the spirals, it was wound in paper, and fastened *externally* on the spiral, parallel to its axis. When a right-hand spiral was used, the needle was magnetic after the discharge, and its north pole turned to the positive side.

5. The same experiment as the former, but the spiral is left-handed. The north pole is now turned against the negative side.

In this and in the former experiments, the poles of the needle were in an inverted direction, as in the 1st and 2d experiments. This may be rendered more striking, by putting in the same experiment a needle in glass or paper *within* the spiral, and attaching another also in paper on the *outside* of the spiral. On transmitting the discharge, both needles will be magnetic, but their poles inversely situated. This experiment was, we believe, first made by some Italian philosophers, but with galvanic electricity: we doubted its correctness on making it the first time, but we found it to answer afterwards.

6. Round a glass-tube was twisted a spiral of soft iron. In the tube was a brass-wire connected with the battery. In this way the battery was discharged through the brass-wire. Then, taking away both the tube and the brass-wire, the steel spiral wire was found magnetic. If its turns went to the right, its north pole was towards the negative side, but if to the left, to the positive side of the battery. The ends of this curious spiral magnetic needle, being brought together, it shewed of course no magnetism, but when loosened again, its magnetism appeared.

7. A small glass-plate was placed on a straight copper-wire. On the glass, at right angles with the brass-wire, was laid a needle. The electric discharge being thrice passed through the brass, the needle was found strongly magnetic. The needle's north pole was turned to the left hand, the observer facing the side of the battery.

8. The same experiment repeated, with this difference, that now the needle was under the glass-plate, and the brass-wire above it. The poles of the needle were now in an inverted situation, the north pole to the right of a person with his face to the positive side of the battery.

9. A brass-wire was bent as ABC, Plate V. Fig. 8. Over this was laid a glass-plate, and on this a needle *abcd*. The end A of the brass-wire being connected with the positive part of the battery, and B with the negative, the discharge effected, the needle was found to have acquired *three* magnetic poles, *ab* and *cd* being south poles, and *bc*, the middle of the needle, a north pole.

10. The same experiment repeated, with the needle under, and the brass-wire above the glass. The ends *ab* and *cd* were now north poles, and the middle, *bc*, a south pole.

11. A brass-wire AB, was bent as in Fig. 9. On this was laid a steel-wire CD, a glass-plate being between them. The end A was connected with the positive, and B with the negative side of the battery. This battery was thrice discharged. The steel had acquired as many poles as the brass-wire made turns. They are marked in the figure by N north, and S south poles.

12. The same experiment as the former, only the steel-wire undermost, then the glass, and next the connecting-wire. Whereever in the former experiment a north pole was formed, there was now a south pole, and reciprocally. It was found advantageous in these experiments to employ tin-foil attached against the glass-plate, instead of brass-wire.

13. A needle was placed in the same direction, or parallel to the connecting-wire, a glass-plate being between them. The needle acquired no magnetism, though the battery was repeatedly discharged.

14. A steel *magnetic*-needle was placed parallel to the connecting-wire, and above it a glass-plate between them. After repeated discharges of the battery, the needle was found to have lost its magnetism.

15. The electric battery was repeatedly discharged through a magnetic needle. The needle lost its magnetism.

It is quite unnecessary to state, that many of these experiments have been made before by others; but as much uncertainty prevails amongst philosophers respecting the result, we thought it advisable to transmit you the whole series, of which of course you will make whatever use you please. I am, &c.

UTRECHT, 29*th Sept.* 1821. G. MOLL.

ART. XIV.—*Notice respecting Dr* WALLICH'*s Journey in Nepaul; being an Extract of a Letter from Dr* WALLICH, *Superintendant of the Botanical Garden near Calcutta, to Dr* FRANCIS HAMILTON. *Dated, Nepaul, 28th March,* 1821 *.

I ARRIVED here on the 21st of December last, and hope to remain until the 1st of November. I am accompanied by a noble establishment of all my painters, some good gardeners from Calcutta, and several of my apprentices, and have obtained permission to investigate the whole valley in which the capital is situated, together with all the mountains immediately bounding it. You may rest assured, that I shall avail myself of the opportunity in the best manner I can, when I tell you, that nearly two hundred baskets, (each a man's load,) have been already sent down to the Botanical Garden at Calcutta, filled with roots and parasitical plants, mostly packed in moss. This, together with ten immense chests of specimens, (partly, however, what had been dried last year by your old plant collector Bharat Singha,) will gain me credit for being at least a tolerable pioneer.

Many specimens of animals have likewise gone down to Lady Hastings, who transmits them to the Edinburgh University, and to General Hardwicke, who has already sent a drawing, description, and some skins of a majestic Buceros to the Linnæan Society. He informs me, that it is the *Buceros Ecavatus* of Shaw. I have also sent down a capital skin, with the head attached, of the true Ovis Ammon, or Argali, (Hamilton's *Nepaul*, p. 94.) and a drawing of a noble large tail-less deer, which General Hardwicke takes to be the *Cervus Pygargus*. The animal itself we have alive, with a number of beautiful birds, and a male and female wild goat, which probably is altogether undescribed, unless you have seen it here †.

You would no doubt be surprised to see how much the people here, and the valley itself, have been improved, during the 20 years since you were in the place. The British Residency is about a mile and a half from Kathmandu; and is a very neat building, surrounded by a most charming garden, full of European trees and plants, which, as you may imagine, thrive here excellently. There are, besides, several other buildings, for the accommodation of the officers attached to the escort. We have an excellent carriage-road to Lalita Patun; a fine bridge having in that direction been thrown over the Vagmati, and another to Balaji, besides a number of fine rides.

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* An Account, by Dr Wallich, of the botanical discoveries made in Nepaul, previous to his arrival there, will be found in this *Journal*, vol. i. p. 376.

† I have not.—F. H.

The chief minister, during the minority of the present Raja, whose father died a few years ago of the small-pox, is Bhim Sen, or rather Singha, mentioned in your account of the kingdom. He is called the General, and certainly deserves great credit for his fine and well disciplined soldiers. He is at present about forty-four years old, and is a fine interesting man, who is much liked by us all. He lives in a fine house, four storeys high, which he has built in Kathmandu, with fire-places, pictures, chandeliers, &c. He dashes away in the uniform of an English general, wearing sometimes the Star of the Order of the Garter! Two of his relatives, Maktibas Singha, a captain attached to his staff, and Vazir Singha, a colonel, commanding at Palpa, have also adopted splendid and rich English uniforms; as have also several other officers, whom I have seen at the Raja's court.

Your old friend Brahma Sahi *, who attended you up to Nepaul, and was afterwards governor of Duti †, died a few months ago; having previously lost his brother, Rudravir, at Saliyana ‡.

The old venerable and noble temple of Swayambhu §, having been struck by lightning, got in 1817 another magnificent top, replaced under the auspices of the Deva Dharma Raja ‖, who sent a detachment for that purpose. Of course the new top is round, as you properly remark that the old one was.

I have procured many geological specimens, which, with such remarks as my ignorance in that science will permit, I shall send to my chief patron Mr Colebrooke. I have numberless musci for Dr Hooker; of Mr Brown's lyellia I have specimens with-

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* See Hamilton's *Nepaul*, pp. 254, 255, 261, 298, 301.

† *Ibid.* 279, 282, 287, 292, 293.

‡ *Ibid.* 261.

§ *Ibid.* 208, 211.

‖ *Ibid.* 56, 119, 120, 121, 122.

out number, in every possible stage, both dried and in spirits. For Mr Roscoe, Mr Lambert, Sir J. E. Smith, Mr Rudge, Dr *Graham, Dr Taylor, and Colonel Beaumont, I am making* large collections, but, above all others, for the Court of Directors, and his Majesty's garden at Kew. I hope I shall have some things to add that are new even to your ample collection, because I ought at least to have that advantage, in consequence of the matchless facilities which I enjoy, and of which, I know well, you were deprived.

ART. XV.—*Notice of Mineralogical Journeys, and of a Mineralogical System*, by the late Rev. Dr JOHN WALKER, Professor of Natural History in the University of Edinburgh.

I BEGAN to collect minerals in the year 1746, when attending the Natural Philosophy Class, and was first led to it by the perusal of Mr Boyle's works, and especially his Treatise on Gems. In this pursuit I was accompanied by two of my most intimate companions at the time, Edward Wright and Alexander Wight. We often traversed the King's Park, the sea-shores between Cramond and Musselburgh, and visited the quarries and coalleries near Edinburgh; but had no book at the time, to direct us concerning the species of minerals, but Woodward's Catalogues. After studying the works of Boyle, Becker, Stahl, Boërhaave, and some others, I attended Dr Plumer's course of chemistry in the year 1749, and became still fonder of mineralogy.

Soon after this, I removed to Newhall, where I had the opportunity of observing and collecting the minerals in the southern parts of Lothian, and in Tweeddale. The year after, on a visit of two or three months at Moffat, I had the same opportunity in Annandale. The Hartfell Spaw was then newly discovered; and the experiments I made upon it, were published in the Philosophical Transactions. The most interesting part of the paper, was the discovery of the particular mineral from which that water derives its mineral contents.

In the year 1753, I went to Galloway; and, till the year 1757, had occasion to obtain an extensive view of the minerals of that country, and of the stewartry of Kirkcudbright. During that time, I transmitted to the Edinburgh Society a collection of Marles, and other natural manures, for which I received a Silver Medal; and, for a second collection of the same sort, a Gold Medal was adjudged to me.

It was this that first made me known to Dr Cullen. I attended his course of chemistry two winters; and, being favoured with his friendship and intimacy, I became more and more attached to mineralogy, which indeed was at that time his own favourite pursuit.

During the short while I lived at Glencross, I went one season to the Goat-whey, in Breadalbane, along with Dr Cullen; when our whole time was occupied with examining and collecting the minerals in that part of the Highlands. Another excursion I made into Fife; when I examined that country, the shores of the Tay, and Kinnoul Hill. A third was made to Clackmannanshire, when I visited the silver and cobalt mines at Alva, and the copper mine at Airthry, which were then worked.

During my long residence at Moffat, I collected, in a number of short tours, all the remarkable minerals in Dumfries-shire, the Forest of Selkirk, Tiviotdale, Ayrshire, and Clydesdale. I visited the lead-mines at Mackrymore, the copper mines at Covend, and the mines of antimony in Eskdale. Leadhills and Wanlock being within a forenoon's ride, I frequently visited the mines at these places, and went down [illegible] them to the greatest depths. They are not only the richest and most extensive, but the most varied in their productions, of any in Scotland. Though I may have been at these mines about thirty times, I never paid one visit in which I did not find something new. Between the years 1761 and 1764, I found in those mines the Strontianite; the Ore, and the Ochre of Nickel; the Plumbum pellucidum of Linnæus; the Plumbum decahedrum and cyaneum, both undescribed; the Saxum metalliferum of the Germans; the Ponderosa aërata of Bergman; and the Morettum, which afterwards appeared to be a peculiar sort of Zeolite. All these were here, for the first time, discovered in Britain; besides the green, grey, and yellow ores of lead, with other minerals which are rare, and seldom met with in other places.

In the year 1764, I was commissioned and directed by the General Assembly, to make an extensive journey through the Highlands and Islands, in order to obtain accurate information concerning the distribution of the Royal Bounty, the state of the Schools, and Missionary Ministers supported by that fund, and concerning the general state of Religion. I was at the same time requested by the Annexed Board to make observations on the natural productions, and on the state of agriculture, manufactures, and fisheries, in those countries. This was a most laborious expedition. It lasted from May to December. But I was young and strong, with a good heart to the work, in all those departments.

Being favoured with one of the King's cutters, I had the best opportunity of traversing the islands, and the remote western coasts. I was encouraged to collect extensively all the singular minerals I met with, and in large masses, as their conveyance home by the cutter was so easy, and which is a matter so difficult in any other way.

Not long before I set out, Dr Cullen had received the first German edition of Cronsted's Essay, of which he was so fond, that he carried it for several weeks in his pocket. He translated to me the leading characters of Cronsted's new and peculiar classes. He was particularly anxious about the Zeolite; and it was in consequence of this, that I first observed it among the basaltic rocks at the Giant's Causeway, though afterwards in greater plenty and variety in many of the islands.

The mines of Isla were then worked, and afforded several rare minerals. The beautiful carnation marble of Tirey; the white marble of the same island, with green transparent schorl; the white statuary of Skye; the green serpentine and Lapis nephriticus of Iona; the obsidian of Eig; the green jasper of Rume; the amiantine rock of Bernerey; and the black lead of Glenelg, were then first made known.

After examining all the coasts from the Shore of Assynt, to the Isle of Sky, I there parted with the cutter. I then traversed the countries of Glenelg, Kintail, Glenshiel, and several districts of Lochaber; examined Morven, and the mines of Strontian. There I found several rare minerals, and particularly that singular substance, since called the Strontianite, in great plenty;

though I had observed it but very sparingly, three years before, in the Mines at Leadhills *. My return to the south was by Glenspean, Fort-Augustus, Coryaroch, the country of Badenoch and Drumalbin, to Taymouth.

In the year 1771, I was again commissioned, in like manner, to visit those islands and parts of the Highlands which I could not overtake in the former journey. At that time, I entered the Highlands by Balquhidder and Strathearn. I examined the high mountain of Benmore, and the mines of Tyandrom. In the latter, I found nothing uncommon, excepting a beautiful crystalline ore of zinc. I proceeded northwards from that place, through the desert country that reaches to Lochaber, and examined Bennevis, the highest mountain in the island. After surveying the countries of Upper, Middle, and Nether Lorn, I went through all the Lorn Islands, which afford to a mineralogist much interesting matter of observation. I then travelled through the districts of Argyle and Cowal, and finished the journey, by an examination of the Isle of Bute and the Cumbrays.

In these two journeys, I visited every inhabited island of the Hebrides, excepting Arran and St Kilda; a still greater number of those islands which are not inhabited, and all the Western Highland countries, from the Clyde to the Shore of Assynt, collecting every where all the remarkable minerals that occurred.

A considerable addition to my collection of minerals was made in the year 1778, in a journey through Stirlingshire, Perthshire, Forfarshire, the Mearns, and Aberdeenshire; and, since that year, by an examination, at different times, of West and East Lothian, Renfrewshire, and the county of Berwick.

Such have been the opportunities of forming a collection of the minerals of Scotland. At different times also, I had occasion to traverse most of the counties in England, from the Border to London, on the east, and from Carlyle to Bristol, on the west side of the island; when I omitted no opportunity of preserving whatever was remarkable in the mineral kingdom. But

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* It is not generally known, that at one period, small quantities of strontites were found at Lead Hills; and the fact in the text proves, that to Dr Walker the merit is due of having determined mineralogically that Strontites was a new mineral species. Dr Hope afterwards, by the *discovery* of the strontitic earth, added to the interest of the determination of Dr Walker, and proved that strontites was also a new chemical species.

besides the minerals which I myself have thus collected in their native places, I have, from time to time, received great additions to my collection from other persons, and from other countries.

From these sources now enumerated, my collection of minerals has been formed. But it is requisite to take notice of the order in which I have arranged them.

I had not been long engaged in the study of minerals, till I became sensible of the great defects in mineralogy, arising from the want of accurate systematical arrangement. It was evident forty years ago, and is still evident, that this science has been much neglected, while the other branches of natural history have been highly improved. Having become acquainted with the necessity and great utility of method in botany and zoology, I could not but regret the want of it in the mineral kingdom; and was persuaded, that the improvement of mineralogy must be conducted in the same manner in which these two other branches of natural history have been brought to such perfection.

With this view, I constructed what was termed *Elementa Mineralogiæ*,—a treatise composed of aphorisms, after the manner of LINNÆUS's Fundamenta Botanica. These have, for many years, remained in manuscript, and only served as rules to direct me in what I thought the reformation and improvement of the science.

To ascertain the proper language in mineralogy, appeared the first step towards its improvement. Nothing had ever been done in this article, excepting a short sketch offered by LINNÆUS, which, although excellent so far as it went, certainly required to be much enlarged. The language used in the description of minerals still remained vague, inaccurate, and frequently absurd. The science was loaded with superfluous and indefinite terms, used even by the best writers. To remedy this, it was endeavoured to arrange and fix the terms of the science, with proper definitions, wherever they were necessary. This was attempted in the *Delineatio Fossilium*, a small treatise printed in the year 1781, but intended chiefly for the use of the students who attended my class.

The next object was the classification of minerals. This can only be done by their external and internal, or, in other words, by their natural and chemical, properties.

It is now sufficiently evinced, that the numerous minerals in the globe cannot be investigated, discovered and ascertained, by either of these two methods, independent of the other. This leading principle was the maxim of the two best judges I have ever known, Dr Cullen and the Earl of Bute, whose opinions and instructions on the subject I always found judicious and useful.

An arrangement of minerals, founded merely on their natural characters, has been often attempted, but has always been found unavailing and useless. On the other hand, a method strictly chemical, as that of Bergman, exclusive of all natural characters, though necessary and useful in the science of chemistry, is utterly incapable of discriminating the numerous minerals in nature.

The most useful system of minerals must therefore be a mixed method, founded on their natural and chemical qualities combined,—the chemical properties to form generally the leading character of the classes and orders; and the natural properties, the subordinate and distinctive character of the genera and species,—a method, if properly executed, equally useful to the naturalist and the chemist.

Upon this principle, a *Schediasma Fossilium*, or a general enumeration of minerals, according to their classes, orders and genera, was printed in the year 1782. Afterwards, in a larger treatise, entitled, *Classes Fossilium*, printed in the year 1787; the natural and chemical character of each class, and of each order, was delivered at length. A more extensive work on the subject still remains in manuscript, which I have hitherto only exhibited to the students attending my lectures. It contains the natural and chemical character of each genus of minerals, accompanied with the synonyms of authors, and incidental observations.

After a careful survey of all the systems of minerals that have been formed, I was convinced that they are all too confined in the number of members or divisions, of which they are composed. The minerals now known are already too numerous to be arranged with perspicuity, under any small number of classes and genera; and the number of known minerals is certainly small, compared with what probably will be brought to light.

It appeared, therefore, necessary, even at present, to enlarge considerably the number of divisions in the mineral system.

In the catalogue, minerals are distributed into classes, orders, genera, species and varieties. This fivefold division, though arbitrary, is excellent; and has now, from experience, been found the best in the arrangement of natural bodies. It is even applicable and commodious in other departments of science. Dr Cullen thought that no other should be followed in mineralogy; and he accurately observed it himself, in his nosology, in the arrangement of diseases. He certainly did much in ascertaining the classes, orders and genera of diseases; but always regretted, that neither his opportunities nor his life were sufficient to ascertain the species. The same complaint may be applied to mineralogy. The classes, orders and genera, may be defined; but to determine the species is difficult. It is a difficulty, however, which, to a great degree, may be obviated or removed.

In consequence of these ideas, the method of minerals which I constructed, previous to the year 1787, comprised 19 classes, 67 orders, and 323 genera; a greater number of divisions than had yet appeared in any mineralogical system. These genera comprehended all the minerals I had collected, all that I had ever seen in numerous collections, and all that I had found sufficiently described by mineralogical writers. This number of genera, I believe, cannot well be much lessened, but must necessarily be enlarged by future discoveries. Since the year 1787, it has been requisite to add to this number 10 new genera.

The catalogue of my collection contains 1569 species and varieties of minerals, arranged under the above genera; but of these there are so many duplicates and varieties of less note, that the number of specimens may probably amount to above 3138. These, however, do not form the whole of my collection. They are extracted from the general register of my museum, which contains many minerals, that, for want of examination, could not be inserted in their proper places in the catalogue.

N. B. This MS. was written several years before Dr Walker ceased to lecture, and before he had adopted views still more agreeable to the Natural History Method *.

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* The collection, we understand, will soon be arranged for public sale by the Trustees of Dr Walker.—Ed.

ART. XVI.—*Observations on Water Spouts, by the* Honourable Captain NAPIER, R. N., F. R. S. E. In a Letter to Dr BREWSTER.

MY DEAR SIR, *Thirlestane, July* 17. 1821.

IN consequence of a wish expressed in the last number of the Philosophical Journal, that any of your nautical readers, in possession of facts relating to the various phenomena of the "Water Spout," would communicate such particulars and observations as in themselves appear interesting; I take the liberty of offering you the following observations, with the remarks made at the time, when the facts and appearances exhibited by this extraordinary phenomenon were deeply impressed upon my mind.

On the 6th September 1814, in latitude 30° 47′ N., and longitude, *per* chronometer, 62°.40′ W., at 1.30 P. M., the wind being variable between WNW. and NNE., the ship steering SE., an extraordinary sort of whirlwind was observed to form about 3 cables length from the starboard bow of H. M. S. Erne. It carried the water up along with it in a cylindrical form, in diameter to appearance like that of a water-butt, gradually rising in height, increasing in bulk, advancing in a southerly direction, and, when at the distance of a mile from the ship, it continued stationary for several minutes, boiling and foaming at the base, discharging an immense column of water, with a rushing or hissing noise, into the overhanging clouds; turning itself with a quick spiral motion, constantly bending and straightening, according as it was affected by the variable winds which now prevailed alternately from all points of the compass. It next returned to the northward in direct opposition to the then prevailing wind, and right upon the ship's starboard beam, whose course was altered to east, in hopes of letting it pass a-stern. Its approach, however, was so rapid, that we were obliged to resort to the usual expedient of a broadside, for the purpose of averting any danger that might be apprehended, when, after firing several shots, and one, in particular, having passed right through it at the distance of one-third from its base, it appeared for a minute as if cut horizontally in two parts, the divisions waving to and fro in different directions, as agitated by opposite winds, till they again joined for a time, and at last dissipated in an immense dark cloud or shower of rain.

The near edge showered in large heavy drops on the ship's deck, until the cloud was quite exhausted.

At the time of its being separated by the effect of the shot, or more probably by the agitation occasioned in the air by the discharge of several guns, its base was considerably within half a mile of the ship, covering a portion of the surface of the water, at least half a furlong, or even 300 feet in diameter, from one extreme circumference of ebullition to the other, and the neck of the cloud into which it discharged itself, appeared to have an altitude of 40° of the quadrant, while the cloud itself extended over-head, and all round to a very considerable distance.

Allowing, then, from the ship, a base of a little more than one-third of a nautical mile, say 2050 feet, and an angle of 40° to the top of the neck, we shall then have, for the perpendicular height of the spout, about 1720 feet, or very nearly one-third of a statute mile. A little before it burst, two other water-spouts, of an inferior size, were observed to the southward, but their continuance was of short duration.

When danger was no longer to be apprehended, I observed the barometer, and found it at $30\frac{1}{10}$ inches, with the surface of the mercury very convex, an appearance which it had not assumed when at the same height at noon, about two hours before; the thermometer stood at 82°, having risen one degree since that time.

During the continuance of the water-spout, and the subsequent rain, which might be a little more than half an hour, the wind blew from all points of the compass at different times, generally shifting at opposite points, never stronger than a fresh breeze for a moment, but in most instances quite light. It was unattended with any thunder or lightning, and the water that fell from the cloud, and was caught in the foot of the driver, was perfectly fresh.

Having witnessed this extraordinary phenomenon, I endeavoured to ascertain its cause, taking for granted the following

First, "That water in a vacuum rises only to the height of 32 feet," or, in other words, "that a column of water 32 feet high, is equal in weight to a column of the atmosphere of the same base." *Secondly,* "That a column of mercury 29½ inches high *in vacuo,* is equal to the same." *Thirdly,* "That heat rarifies the air and causes a vacuum." *Fourthly,* "That when the lower atmosphere is so much rarified as to become lighter than the impending clouds, that these clouds or vapours fall and disperse on the surface of the earth in the shape of rain or moisture." *Fifthly,* "That when the clouds descend, the mercury in the barometer also descends, and that when the vapours rise through the lower atmospheres, becoming again more dense than the vapours themselves, that the mercury in the barometer rises also."

With these data, were next noted the various phenomena, as observed to be connected with the water-spout itself.

1*st,* Low, heavy, black clouds were seen to the southward at noon, the barometer standing at $30\frac{1}{10}$ inches, and the thermometer at 81°, in a constant current of cool air; the atmosphere, in general, becoming hazy, even thick in some places, close and very hot,—the wind variable and attended with occasional drops of rain. A whirlwind next taking place, drawing the water up with it, apparently in a state like vapour or steam, advancing in a southerly direction to the above-mentioned dark impending clouds, increasing also in height and bulk, with a quick spiral motion, till it came in contact with the end of a cloud which rather drooped to meet it; then discharging great quantities of water, not in a solid bulk, but in short unconnected streams or streaks as it were, attended with a rushing or hissing noise. 2*dly,* That after some time, it returned with considerable velocity to the northward, in opposition to the wind prevailing at the ship, the water at the base boiling with a white foam, part projecting outwards to a certain circumference, and part arising in thick dark vapours, which gradually arranged themselves into thin streaks, as they gained in ascent towards the clouds, till the whole was dispersed by bursting into a heavy shower. 3*dly,* That the clouds descended, or came gradually nearer to the surface of the sea, before they were perfectly saturated, previous to bursting. *4thly*, That these clouds extended in large dark masses, over a great part of the western hemisphere, and were quite thick and dark over-head. *5thly*, That the water-spout, at the base, covered, in diameter, about half a furlong of water; and, in its most slender part, about $\frac{2}{3}$ds upwards, it was to appearance about 6 feet in diameter; and that, in height, it might be estimated at 1700 feet: and, *lastly*, That during the operation of these extraordinary phenomena in the atmosphere, the mercury in the barometer did only become more convex than before, with the thermometer rising one degree.

In proceeding to examine the subject, we shall suppose that the water rose from the sea *in vacuo*, or rather in a cylindrical space approximating to that of a vacuum, and that it was caused so to rise, *in part*, by the pressure of the atmosphere circumscribing the base of the said vacuum. Having allowed so much, we can go no farther without violating the well known law, that "water cannot rise *in vacuo*" above 32 feet; admitting, therefore, that it was even assisted to that small height, we shall have availed ourselves of the theory, as far as truth or reason can justify.

If we say that water is drawn upwards by the suction of a cloud, as proposed to be exemplified by Mr Oliver with a quill over a glass of water, we shall then begin to establish the theory of "suction," perfectly irreconcileable, also, with the equally well-known fact of the gravity of the atmosphere. Besides, the force of Mr Oliver's lungs, over a glass of water, can bear no analogy to that of a cloud overhanging the surface of the sea. It appears also strange to talk of an *empty* cloud, or a *half exhausted* cloud, for clouds are not *aerial bags*, as some would have them to be, but vapours overhanging the earth at different heights from it, according to the proportion of humidity or density contained in themselves, and which, when, by reason of their greater weight, they fall within the sphere of the earth's attraction, begin to discharge themselves in rain, till, being reduced in size and density, if not totally consumed, they naturally rise above the sphere of attraction, and, regaining the higher parts of the atmosphere, again attract each other, and repeat such operations to the end of time.

Setting aside, then, the theory of suction, and the idea that the water-spout could rise in a body to the clouds, by the pressure of the circumambient atmosphere alone, we shall have the following probabilities to bring us to a more rational conclusion.

1st, That many opposite currents of wind, all pointing towards a certain centre, and coming in contact with each other with unequal forces, cause a rotatory motion or current of themselves round a central space, which, not partaking of an equal or its former pressure, naturally becomes rarified by the existing heat, to such an extent, that it speedily acquires a state in a great degree approximating to that of a vacuum. *2dly*, This continued rotatory motion of the air, forms that which is usually denominated a *whirlwind*; and the pressure of the external atmosphere at the base, forcing the water to a reasonable height up the rarified space within, it is then carried upwards by the mechanical action of the wind, in light and unconnected streaks. The space at the bottom now becoming void, is regularly replenished by the pressure from without, till the whole spout is in due time thus perfectly completed.

The water having now arrived at the region of the clouds, it is naturally attracted, diffused and connected with and among them, increasing in density and extent, till the lower atmosphere becoming now lighter than the clouds above, these enormous masses gradually settling downwards, distend, burst and dissipate in rain.

That the mercury in the barometer did not fall with the rain, but, on the contrary, became considerably more convex, was visible from observation, and may be accounted for in the following manner: That during the whole operation of the water-spout, which continued not more than 30 minutes, the commencement was too sudden, and the duration too short, to cause any change indicative of what actually took place; and that this convexity only prognosticated what *would* have taken place, had there been no water-spout at all, and what actually did happen afterwards, viz. a very clear atmosphere and hot sultry weather.

Although this phenomenon was rather terrific in appearance, yet I am not inclined to think it would have been attended with any serious calamity to the ship, had even the whole quantity fallen on board, allowing the loftier sails to have been taken in, the hatches battened down and scuppers open. The cylinder or spout coming in contact with the masts and rigging, would naturally be destroyed; and the air rushing in instantaneously to restore the equilibrium, the torrent would be thus checked in its fall to the mere weight or force of a tropical descent. I have heard many reports of ravages committed by these aqueous meteors, but never yet met a person who had actually witnessed or experienced any such distressing effects.

Upon comparing the present account with that of Mr Maxwell's, in your last Number, illustrated by a very striking representation, it appears that, *when completed*, the two spouts are almost perfectly alike, but originally had derived their first formation from different sources.

The cause of the whirlwind must be the same in all cases.

Mr Maxwell distinctly states, "that at the first formation, the black cloud drops from a level surface into a conical form, before the disturbance at the surface of the sea is visible. The black conical cloud continues to descend till it almost reaches the surface of the sea, and the smoke-like appearance at the surface rises higher and higher, till it forms an union with the cloud from which that spout appeared to be suspended."

In this instance, the whirlwind must have commenced and been complete, sooner in the region of the clouds than at the surface of the sea, and thus attracted and brought down with it all those vapours that first came within its influence, meeting in its descent a portion of water, of a "smoke-like appearance," rising from the sea itself, contained, of course, within the vacuum there more recently completed.

This appears just as probable as that the whirlwind and spout should have commenced, first at the surface of the sea, and then risen upwards, as in the other instance; for it has been seen that this spout traversed a considerable distance to the southward, before it came in contact with a cloud, which "rather drooped to meet it." In both instances, however, the clouds and sea were connected by a long column of water, but the latter having had its origin at the sea, it increased to a much greater bulk, even to the formation of clouds themselves; whereas the former, having originated aloft, acted merely as a canal or duct, through which the clouds discharged themselves into the ocean below.

In the case given by Mr Maxwell, the spout must have been of smaller dimensions, and a less terrific appearance than the subject of the present paper, and from the very obvious cause of its having originated aloft instead of below.

In the formation of whirlwinds, there can be no fixed or determinate rule, why a preference should be given to their being generated at any one particular altitude between the clouds and sea, in preference to another; and if we take it for granted, that they are essential to the formation of water-spouts, or that a spout cannot exist without a previous whirlwind, it then naturally follows, that the dimensions of such a spout must, in a very great measure, depend upon the original proximity of the whirlwind to the sea itself, the sea affording a more copious supply of aqueous material, than the less substantial fabric of a cloud.

The water that fell into the foot of the driver, on board the Erne, was certainly quite fresh to the taste, and it will be difficult to ascertain when and where the process of distillation was effected. In the mean time, however, it may reasonably be admitted, that the admixture of the salt-water from the sea, with the fresh-water in the clouds, the latter being in far greater proportion than the former, is of itself sufficient to account for the chemical change that had thus taken place in so short a space of time.

Whenever we are better acquainted with the effect of coming in actual contact with one of these giants of the deep, we shall then be enabled to comply with the recommendations inserted at the end of Mr Maxwell's paper; but as there does exist at present in the minds of all seamen, a most indescribable aversion to any intentional familiarity with meteors of such doubtful tendency, it may be difficult to find one who shall court a closer acquaintance for the mere purpose of science, in preference to the usual employment of every individual exertion of getting out of the way as fast possible. In case of the ship's being becalmed, and every thing secured, and when one cannot do better, as was very much the case on board the Erne, it would be well to make every possible remark and observation, but such opportunities are said to be of very rare occurrence.

ART. XVII.—*Observations on Vision through Coloured Glasses, and on their application to Telescopes, and to Microscopes of great magnitude.* By DAVID BREWSTER, LL. D. F. R. S. L. & Sec. R. S. Edin. [*]

I AM not aware that any observations have hitherto been made on the subject of vision through coloured glasses. The astronomer has long been in the habit of using them to attenuate the light, and to obstruct the heat of the solar rays [†]; the painter occasionally employs them to give a warmer tint to his landscape; and, in cases where the human retina is extremely sensible to light, or where other parts of the eye are not capable of sustaining its strong impressions, coloured media have been adopted, to reduce the incident rays to a proper degree of dilution.

The colour generally selected for the relief of tender vision, has been a bluish or yellowish *Green;* and the choice seems to have had no other foundation, than the vague analogy that the eye was best fitted to bear the impression of those rays which Nature had shed most abundantly over her works. Fashion has, however, substituted a sort of *Blue* or *Grey* medium in place of green; and, unless checked by the application of some principle, may soon carry us through all the colours of the spectrum.

When we consider light as consisting of several distinct rays, differing in refrangibility, and on this account creating imperfect vision, by their imperfect convergence on the retina, it is easy to understand how this imperfection may be removed, by looking through a medium which transmits only rays of a particular colour. In this point of view, every homogeneous colour should afford nearly the same relief; and if we abstract the different heating powers of the coloured rays, which, in ordinary lights, can have no influence, it is difficult to discover any reason why one coloured medium should be preferred to another, provided each of them transmits equal quantities of homogeneous light *.

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[*] Read before the *Royal Society of Edinburgh*, November 19. 1821.

[†] Dr Herschel has published in the *Phil. Trans.* for 1800, p. 255. an account of some very interesting experiments on the power of coloured glasses to intercept different rays, particularly the red, or those which heat most powerfully.

Impressed with this opinion, I was surprised to find, that vision through a piece of blue glass became so painful to the eye, that it was not able to endure the impression for any length of time. In order to discover the cause of this unexpected effect, I examined with a prism the light of a candle transmitted through the blue glass, and found that it had the remarkable property of absorbing only the middle rays of the spectrum, viz. the *Green*, *Yellow* and *Orange*, and transmitting the *Violet* and the *Red*. The spectrum, therefore, consisted of two separate images, the one *Red* and the other *Blue;* and hence the eye was not able to see distinctly by means of rays of such different refrangibilities. When it tried to adapt itself to the blue rays, it became incapable of converging the red ones; and when it endeavoured to converge the red light to a focus, it lost the power of converging the blue. The effect, in short, was the same as if it had attempted, by its muscular power, to adjust itself to two different distances at the same time, and therefore it became completely exhausted with its fruitless efforts to obtain distinct vision.

If the eye is adjusted, so as to see a luminous point through the blue glass, by means of blue light, the blue image of the point will be surrounded with a circle of red light, which is a section of the cone of red rays that the eye has not converged to a focus; and, in like manner, when the eye is adjusted to see the luminous point by the red light, the red image of the point is surrounded with a circle of blue light, which is a section of the cone of blue rays, while diverging from their focus within the vitreous humour.

This striking example of the imperfection of vision through glasses of a compound colour, points out the principle upon which they should be selected. As the coloured glasses which are fitted for ordinary vision cannot be made to transmit homogeneous light, without obscuring the object, we must seek for that colour which produces the shortest spectrum, with the greatest illumination. In this examination, I have tried a great variety of coloured glasses, and have found, that a *yellowish-green* glass has the property required. It almost entirely absorbs the extreme red rays, and extinguishes a very great proportion of the blue extremity of the spectrum. Hence, it not only relieves the eye, by attenuating the incident light, but it improves the image, by diminishing the error arising from its different refrangibility.

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* Glasses which transmit only rays of one colour are very rare, and are of great use in many optical experiments. I have often combined plates of differently coloured glass, so as to produce this effect completely. The only artificial glass which I have met with possessing this property in perfection, is one of a fine blue colour, which transmitted only the red rays of the spectrum.

Having thus considered the influence of coloured media upon simple vision, it becomes interesting to inquire how far the telescope and microscope are susceptible of improvement, by the use of coloured lenses. As the objects to which the telescope is applied, do not admit of artificial illumination, the absorption of the obnoxious rays can only be resorted to, when there is a considerable intensity of light. In viewing the spots of the Sun, for example, and in examining Venus and Jupiter, when near the Earth, some benefit may be derived from the interposition of coloured lenses; but it is principally by extinguishing the secondary tints which remain, even in the best achromatic telescopes, that we anticipate any decided advantage.

With the microscope, however, the case is quite different. The power which we possess of illuminating artificially the objects under examination, enables us to compensate the loss of light by absorption, and as we have also the apertures of the lenses under our controul, we may avail ourselves to a very great extent of the application of coloured media.

In the construction of single microscopes, I have derived great advantage from using both *red* and *green* lenses, particularly when the outline or form of an object was required. In compound microscopes, the lenses may be made either of the same or of different colours, or only one of the glasses may be coloured; and the kind of light to be absorbed, may be regulated by the colour of the object under examination.

In order, however, to derive from coloured glasses the full benefit which they are calculated to afford, the compound microscope should be constructed on a scale of unusual magnitude. I had occasion many years ago to point out the advantages of an enlarged form; and I constructed one about *fifteen* feet in length, with an achromatic object-glass, which produced very superior effects *. Since that time, I constructed another, with a metallic reflector, which was 48 feet in length.

The advantages of large microscopes over small ones, may be considered in reference,

1. To the imperfections of the glass employed.
2. To the spherical form into which it is ground.
3. To the adjustment of the axes of the lenses.
4. To the method of illuminating the object.
5. To the examination of objects placed in cavities; and,
6. To the examination of objects whose parts are placed at different distances from the instrument.

In making this comparison, we shall suppose that the object-glass of both microscopes intercepts the same portion of the sphere of light, which diverges from the object under examination.

1*st*, As the veins and irregularities of glass have a definite magnitude, a lens of a small aperture will be much more liable to have its image injured by any accidental flaw, than one of a large size, and the same may be said of the small pits and scratches which often remain even after the most careful polishing.

2*d*, In the operation of grinding the object-glasses of small microscopes, the optician works at random, and has the power neither of giving them a correct spherical figure, nor of adjusting the axes of their opposite surfaces; whereas in larger lenses, these operations are completely under his controul.

3*d*, One of the principal points to be attended to in the construction of compound microscopes, is the coincidence of the axes of the lenses of which it is composed. This adjustment is seldom made, and indeed is not very practicable when the lenses are small. In the enlarged form, however, the axes of the lenses may be made to coincide with the greatest accuracy, and consequently the performance of the instrument greatly improved.

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* M. Æpinus, in the *Nova Acta Petropol.* tom. ii. p. 45. proposes that the distance of the object from the object glass should be three, four, or five inches, or even half a foot or a foot, in order to allow the light to fall upon the object; and he describes a microscope which he had constructed on this principle, with an achromatic object-glass a little less than three feet in focal length. The aperture of the object-glass was about an inch, and the distance of the object from the object-glass seven inches.

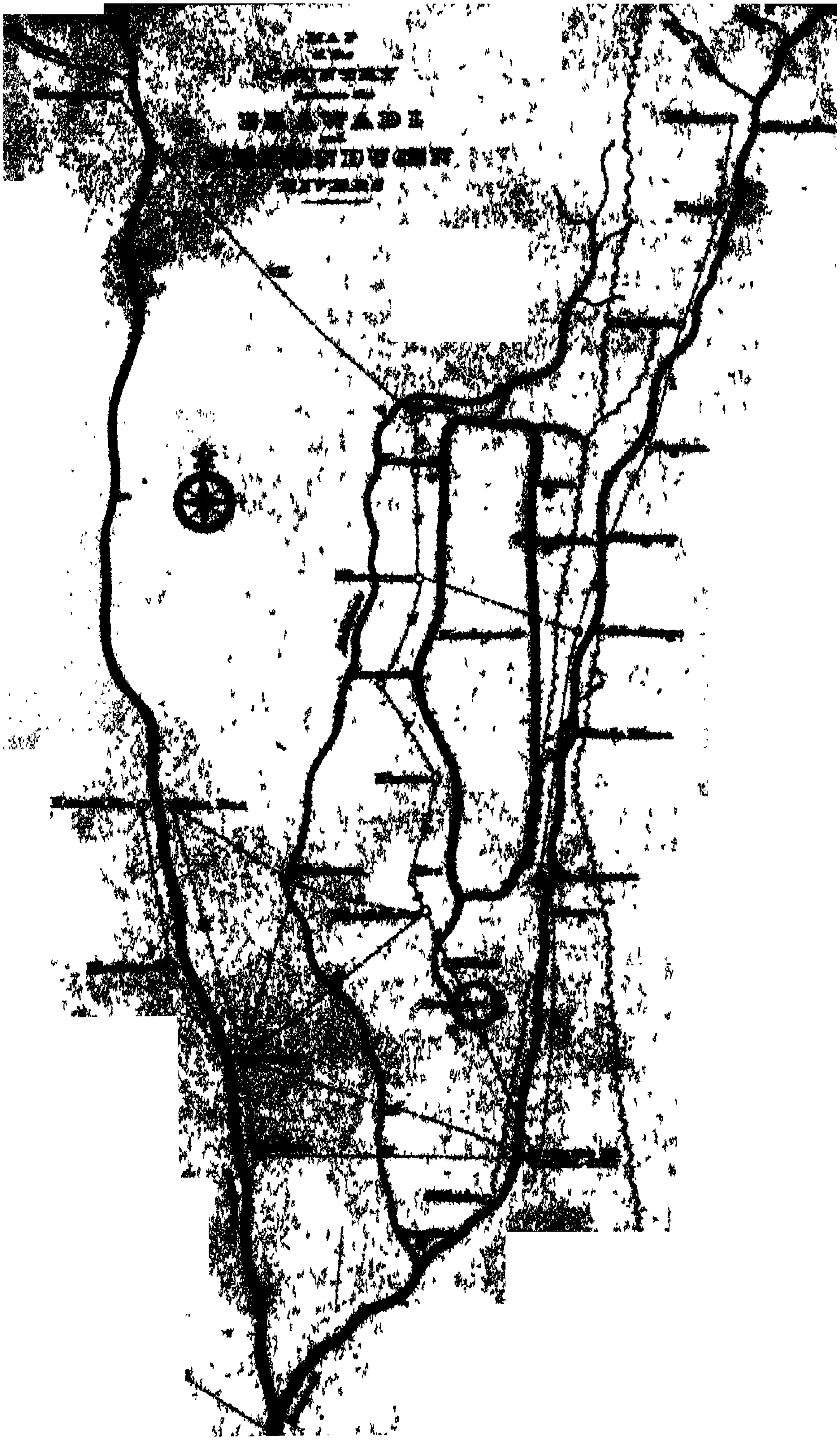
4th, In small microscopes, the power of illuminating the object is very limited, from its proximity to the instrument. The light which it would naturally receive, is obstructed by the head of the observer, and by the body of the microscope; and when the object is perfectly opaque, it is almost impossible to throw upon it the requisite degree of light. In large microscopes, on the contrary, where the object is *one* or *two*, or even *three* feet from the object-lens, we may project upon it any quantity of light that we please.

5th, The ordinary microscopes, both single and compound, are incapable of being applied to objects placed in a cavity, or in the interior of a transparent crystal; but in large microscopes, the depth of the cavity, and the thickness of the crystal, bear no sensible proportion to the distance of the object from the microscope; and the cavity, or any object which it includes, may be seen to the greatest advantage.

6th, In viewing an object of perceptible thickness, such as a fly, through the compound microscope, it is impossible to see the near and the remote parts at the same time, so that a number of successive adjustments are necessary, and even then, we are imperfectly acquainted with its general form and outline. In large microscopes, however, the thickness of the object bears a very slight proportion to the conjugate focal distances of the object-lens, so that the instrument may at once be adjusted to all the parts of it that are within the field of view.

When the object to be examined is an optical structure, such as that exhibited by plates of amethyst, the ordinary microscope is entirely useless, as the figure to be observed is produced by the action of every point of the transparent plate. When the microscope is large, however, the figure is seen with as much distinctness as if it had been formed by a plate of no other dimensions but length and breadth.

Such are a few of the advantages which we may confidently expect from the use of large microscopes. We would recommend them strongly to the attention of naturalists, whose pursuits lead them to investigate the more minute phenomena of vegetable and animal life. The portion of nature which has


MAP
RIVERS

hitherto been subjected to examination, is but of limited extent; and it is only by extending the power of vision, that we can hope to penetrate into new regions. There are worlds within our reach not less interesting, than those which elude our research by their immeasurable distance. The laws which govern them, and the beings by which they are inhabited, are alike unknown to us; and though ignorance has endeavoured to throw an air of ridicule on the study of animalcular existence, yet we may safely affirm, that the functions of minute bodies, must be regulated by laws essentially different from those of larger animals, and that those planetary masses, which astonish us by their magnitude and splendour, afford fewer subjects of scientific research, than those portions of apparently dead matter which we daily trample under our feet.

ART. XVIII.—*Account of a Map of the Country between the Erawadi and Khianduæn Rivers.* By FRANCIS HAMILTON, M. D. F. R. S. Lond. & Edin., and F. A. S. L. & E. Communicated by the Author.

THIS Map, which has been reduced to half the original size, I procured at Amarapura from the slave who communicated the general Map of the empire of Ava, already published, (*Phil. Journal*, Vol. II. p. 262.). All the towns in it are denoted by circles; but the royal residence (Nro-do) or Amarapura, is distinguished by a double circle (Mro); cities are distinguished by a single one, and villages (Rua) are marked by a cross in the centre.

In the reduced map, the distance between the junction of the two great rivers and the capital being 1.89 inch, and the actual distance being about sixty geographical miles, we should have a very little less than thirty-two geographical miles to the inch. According to this, Kaunton, on the frontier of China, the Quantong of Mr Arrowsmith, should be 208 geographical miles from Amarapura; but, according to him, this distance is only 114 miles; nor do I here suspect him of any very material error. In using this map, therefore, no scale can be safely adopted; the more especially as from Mredu to Mænghæn, near the mouth of the Nerinzara, the map reckons seven days journey, while it reckons six days journey to this river from Kani; but, in the map, the seven days occupy only forty-seven parts, while the six days occupy seventy-six parts. I suspect, however, that in the distance from Mredu to Mænghæn, the error is mine, and not that of the slave, and that I have read seven in place of what he intended for three, the Mranma cyphers for these two numbers, when carelessly written, having a considerable resemblance. Whatever want of attention to a scale exists in this map, much useful intelligence may be collected from it, respecting the distances of places, the numbers in Roman characters, as usual, in these maps expressing days journeys, and those in cyphers expressing Dain or Mranma leagues of two and a half British miles road-measure.

In extent, in climate, and in the magnitude of the noble rivers, by which it is bounded, the territory delineated in this map bears a strong resemblance to the Antarbeda or Duab, between the Yamuna and the Ganges in Western India; yet between these two regions there are essential differences. The Antarbeda of Western India consists almost entirely of clay, sand, and loam, in which the slightest vestige of stone cannot be traced; and, farther, it is perfectly level, except where the bounding rivers, working on such soft materials, have excavated channels of great depth, leaving enormous rugged clifts, which, in most places, render a descent to the river very difficult, and totally prevent the farmer from availing himself of their water for irrigation. In the Antarbeda of Eastern India, on the contrary, and parallel to the Erawadi, there is a chain of rocky hills, the foundations of which prevent the river from sinking, so that, during the periodical rains, it inundates a great extent; and, farther, this chain of hills gives rise to a stream, the Mukhiaun, which has been already mentioned, (*Phil. Journal*, Vol. IV. p. 83.), and which is advantageously applied to irrigation, forming two very extensive reservoirs, laid down with care in the accompanying map. From this it would also appear, that the southern portion of this chain of hills, which is very rugged and barren, but not high, and which contains fine quarries of pure white marble, extends to no great distance, that is to say, for only about twenty miles in length, when it is interrupted by a level reaching from Mængun, the usual country residence of the late King, to Kioun-mraun, (Koun-meor, Ren.) near Mowzhzhobo, the residence of his father. At this place the Erawadi comes from a narrow valley, having on the west a continuation of this chain of hills, and on the east the mountains of Koshanpri or Mrelapshan. In this part of the river a rocky island gives room for a celebrated temple, called Sihado Bhura.

The western part of the territory, delineated in this map, towards the south, is level and fertile; but, whether or not the eastern bank of the Khiænduæn consists of lofty inaccessible clifts, like those of the Yamuna, I cannot say; for although rocks extend near to the western bank of the Khiænduæn, the same is the case with the Yamuna, (Jumnah of Rennell). At the latter river, indeed, these rocks in very few places extend into its channel, so as to have prevented it from penetrating to a good depth. By far the greater part, however, of even the eastern bank of the Khiænduæn is bordered by hills, which extend as far to the south as Kanæh.

I shall now make a comparison between this map and the corresponding parts of that given by the native of Taunu, (*Phil. Journal*, Vol. IV. p. 76.) already published.

In the first place, along the Erawadi, we have the following line of distances, in which, it must be observed, there are great differences.

From Amarapura, by the

	Slave's Map; Days.	Taunu Map; Days.	Zabuas Map. Days.
To Kiounmraun or Zingu, nearly opposite,	2	4	3
To Zabbæhnago,	3	2	2
To Kiangnap,	1	...	1
To Thighiain,	1	2	...
To Kasa,	1	3	...
To Miadaun,	1	3	3
	9	14	9

The distances in the map of the slave now under consideration, and in that of the Zabua (*Phil. Journal*, Vol. III. p. 32.) agree so well, that they deserve most attention. Some error has crept into those given by the native of Taunu for the first and the three last stages, which ought to be corrected.

I have already mentioned, that in this part of the Zabua's route, we could only allow eleven British miles for a day's journey, direct distance, which will perhaps give sixteen British miles, road distance, for each individual day; and this is fully as much as I ever found that I could travel in India, carrying with me the usual incumbrances of tents, furniture, provisions, servants, and other accommodations necessary to render travelling comfortable in a country where there are no inns. According to this rate of travelling Kiounmraun, even by the Zabua's estimate, should be only forty-eight miles road distance above Amarapura; but Mr Arrowsmith makes it forty geographical miles in a direct line, which I am confident is too much; nor, on the whole route, can the day's journey give more than nine and a quarter geographical miles direct distance. Reckoning by this rule the eastern boundary of the space included in this map, from Amarapura to Miadaun, will extend about eighty-three geographical miles in a direct line.

Next, for the extent on the western side, from the junction of the two great rivers to the mouth of the Nerinzara, we have, according to this map, ten days journey, besides the space between Badoun and Amræn, which has been omitted. But, in the map by the native of Taunu, (*Phil. Journal*, Vol. IV. p. 76.) the distance is eleven days journey, including the space between Badoun and Amræn. These two authorities may therefore be considered as agreeing tolerably; and, if the days journeys on the Khiænduæn and Erawadi are of a similar length, the western side of this map may be considered as about 101 geographical miles in length; but the allowance taken for the day's journey in the account of the map of Ava by the native of Taunu, would reduce considerably this extent, and such a reduction can be more easily reconciled with circumstances than the greater allowance.

In the seventh number of this Journal, (Vol. IV. p. 83.) I have mentioned, that some maps erroneously place Mænghæn close to the mouth of the Nerinzara. Such is the case in this map; and I have already mentioned another probable error respecting this place, in its being made seven days, in place of three days journey from Mredu. If the latter be the real distance, Mredu being five days journey from Amarapura, Mænghæn will be eight days journey from the same, which would not carry it near so far up the Khiænduæn as the mouth of the Nerinzara; and, in fact, it is laid down by the native of Taunu more than two and a half days journey lower, which I consider to be the actual case.

The extent of this map, at its southern end, reaches from the junction of the Khiænduæn and Erawadi to Amarapura, sixty geographical miles, according to the survey copied by Mr Arrowsmith. This is the breadth of the lower end of the Antarbeda or space between the rivers, only it is rather in an oblique direction. The real breadth from east to west between Amarapura and Badoun, is stated in this map to be two days journey, probably in a very direct line, and free from impediments, this being one of the best cultivated portions of the empire. Allowing, therefore, that each day's journey is actually ten Mranma leagues in road distance, the breadth of the tongue of land at its south end cannot be above forty British miles. This, conjoined with the observations which occurred in treating of this territory, in my account of the native of Taunu's map, (*Phil. Journal*, Vol. IV. p. 81.) induce me to believe, that the course of the Khiænduæn should be placed nearer the Erawadi than has been done by Mr Dalrymple; and that the intervening territory is much narrower than he imagined.

Farther north in this map we have given the breadth of this territory between Kiounmraun and Kanæh, passing through Mouzhzhobo. The road distance between these two places is said to be twenty-six Mranma leagues, or about forty-three geographical miles. The reader may compare this with what I have said concerning this distance in my account of the map by the native of Taunu, where it is estimated at only twenty-nine geographical miles, but this I conceive too little. The map now under consideration affords no grounds for calculating the space intervening between the two rivers farther north.

LENY, 1*st November* 1821.

Art. XIX.—*On the* Comptonite *of Vesuvius, the* Brewsterite *of Scotland, the* Stilbite *and the* Heulandite. By H. J. Brooke, Esq. F. R. S. Lond. M. G. S. &c. &c. Communicated by the Author.

In the Edinburgh Philosophical Journal, Vol. IV. p. 131. Dr Brewster has described a new mineral, and given it the name of *Comptonite.* I have found the crystals of this substance cleave parallel to the planes M and T, Plate V. Fig. 1. the cleavage planes meeting at an angle of 90°. This circumstance, combined with the existence of the planes *o*, *o′*, which meet at an angle of about 177° 35′, shews that the primary form is a rectangular prism, the terminal edges of which are, however, very nearly equal. On three crystals of my own, I have found M on *a* measure 135° 30′, 135° 30′, and 135° 45′; and on the same crystals respectively, *a* on T measured 134° 30′, 134° 45′, 135° 15′. If 135° 30′ and 134° 30′ be taken as the true measurements, the edges of the base terminating the planes M and T, will be to each other respectively very nearly as 56 to 55.

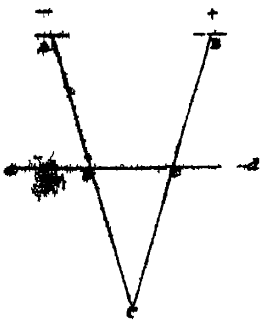
A mineral from Strontian, which has been called in France *Primitive Stilbite*, and was at one time considered to be Apophyllite, is certainly a distinct substance.

I have therefore given it the name of *Brewsterite*, on account of the many important discoveries connected with crystallography, which have resulted from the experimental researches of Dr Brewster. The primary form of the *Brewsterite* is a *right prism*, Fig. 2. whose *bases* are *oblique-angled parallelograms*, M on T measuring 93° 40′, as deduced from the inclination of *a* on *a′*, *c* on *c′*, and *a* on *c*, Fig. 3. I have not been able to cleave the crystals with certainty in any other direction than parallel to the plane P. Yet when an attempt is made to divide them perpendicularly to P, and parallel to T, the new surfaces exhibit traces of cleavage planes.

The inclination of the edge *h* on the edge *i* being 93° 40′, it was necessary to adopt a prism oblique in one direction, as the primary form; and I have preferred placing that prism in the position I have just described, from its agreement with Sulphate of Lime, Euclase, and some other substances belonging to that

PLATE V

Fig 8



COMPTONITE

Fig 1

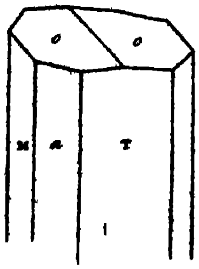
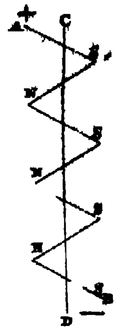


Fig 9



BREWSTERITE

Fig 2

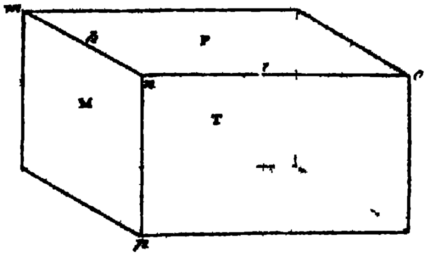
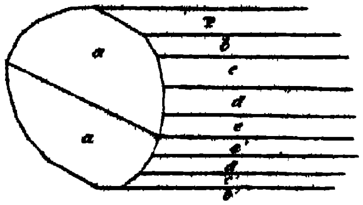


Fig 3



STILBITE

Fig 4

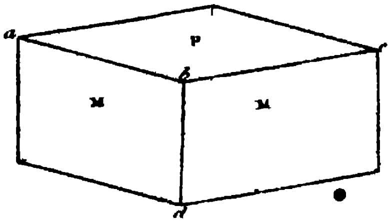
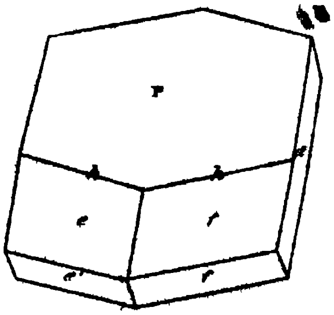


Fig 5



HEULANDITE

Fig 6

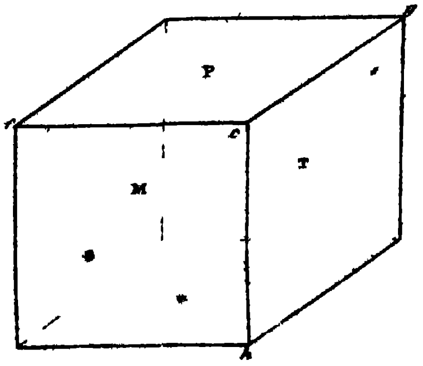
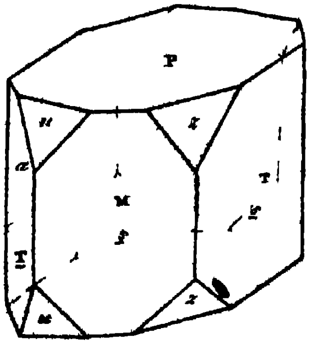


Fig 7



W. Archibald Sculp.

Published by A.Constable & Co. Edin. 1821

class of primary forms, in the facility with which it cleaves parallel to the *terminal* plane, and in the constant brilliancy of the planes developed by this cleavage. Fig. 3. contains all the modifications I have observed on the crystals I have examined, the angles at which some of the planes incline to each other measuring nearly as follows:

P on *a*,	93° 30′
b,	119 30
c,	114 30
d,	112
e,	92
a — *a′*.	172
a — *c*, *a′* — *c′*,	95

Finding on several crystals the planes *c*, *c′*, larger than any of the others, and on one crystal finding those planes alone, I have taken them to fix the ratios of two of the edges of the prism. Supposing them to result from a decrement by one row on the edge *n o*, the edges *n p* to *n m* would be as 35 to 16. And if the planes *a*, *a′* be supposed to result from a decrement by four rows in height on the edge *n m* of the terminal plane, the ratio of *n p* to *n o* would be as 35 to 10.

On examining the Abbé Haüy's varieties of *Stilbite*, I have found, that those which Werner distinguished by the names of Radiated and Foliated Zeolite, are two distinct species; and I am happy in the opportunity which this discovery has afforded me, of associating the name of Mr Heuland more intimately with mineralogy, by calling one of the substances ***Heulandite***, and of thus recording the readiness with which Mr Heuland has on all occasions opened his cabinets to the researches of science, and his very liberal contributions of specimens, whenever they have been required, for the purposes of either chemical or crystallographical examination *. The first of the two species of the Abbé Haüy's *Stilbite*, from which he appears to have deduced his primary form, and for which I shall retain the same name, includes his *dodecaedre* and *epointee* varieties, and is the Radiated Zeolite of Werner.

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* We cannot omit the present opportunity of adding our testimony to the liberality of Mr Heuland, and to his unceasing zeal for the progress of his favourite science. It is fortunate for mineralogy, that the possessor of one of the finest collections in Europe, should be a most generous dispenser of its benefits for the purposes of scientific research.—D. B.

The secondary planes, however, which meet under the angles which he has given, do not occur on any of the crystals I have seen.

The cleavage he describes parallel to the plane *d*, Fig. 5. is easily effected; but there are also natural joints very apparent, parallel to the edges *h h'*, which induce me to consider the *right rhombic prism*, Fig. 4. as the primary form.

In Fig. 5. the measurement of P on *c* or *f* is 120° 30'

$$\left.\begin{matrix} c - f \\ c' - f' \end{matrix}\right\} \quad 114$$

$$\left.\begin{matrix} c - c' \\ f - f' \end{matrix}\right\} \quad 119\ 15$$

These measurements have been taken by the reflective-goniometer on several small crystals, with tolerably bright planes Supposing them correct, and that the planes *c* and *f* result from a decrement, by one row on the terminal edges of the prism, the inclination of M on M', Fig. 4 is nearly 101° 36', and the edge *d b* is to the edge *a b* or *b c* nearly in the ratio of 26 to 31.

The second species included under *Stilbite* by the Abbé Haüy. and to which I have appropriated the name of *Heulandite*, is the Foliated Zeolite of Werner, and crystallises in the form of a *right prism, whose bases are oblique angled parallelograms*, Fig. 6. This species comprehends the *anamorphique* and *octo-duodecimale* varieties, on the latter of which figures the Abbé Haüy has placed four planes, which do not appear on any of the crystals I have examined, and which may be said to be incompatible with the primary form of the mineral *

The planes I allude to, are four of those which he has marked with *u*,—the four which belong to the crystal, I have marked with the same letter in Fig. 7. this being the form under which the mineral most frequently presents itself. It is rather remarkable, that the Abbé should have omitted to give the measure of his plane T on the two adjacent planes *s*, or the measure of *z* on the two adjacent planes *s*; for, although the differences do not exceed 2°, even those might have shewn that the primary form was not that which he had supposed. It is however possible, that he might not have measured these planes. To enable the reader to compare the Abbé Haüy's figures with mine, I have added on three of the planes of Fig. 7. in small letters, (scored under thus, $\underline{s}$, $\underline{T}$), the letters he has used to designate those planes. The measurements on the natural planes of this substance frequently disagree on large crystals; those on which I have most relied, have been taken on small crystals, with the reflective-goniometer, and are as follows:

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* That which has been called Red Stilbite from Dumbarton, is the Heulandite.

z on P,	112° 15′
M,	146 30
T,	148
M — *a*,	114
T — *a′*,	116
M — T,	130
a — *a*,	129 40

From these measurements may be deduced the ratios of the edges *c f*, *c h*, *c g* of the primary form, which are nearly as the numbers 160, 161, 162. These ratios suppose the planes *a* and *z* to result from decrements by one row on the edge and angle of the primary form which they replace.

The figures are drawn merely as diagrams, to render the descriptions intelligible, and with little regard to accuracy of form *.

ART. XX.—*Observations on the Impregnation of Wood with Sea-Water, and on the Fogs of the Polar Seas* †. By WILLIAM SCORESBY, Esq. F. R. S. E. M. W. S. &c.

I. *Impregnation of Wood with Sea-Water.*

IT has been my privilege to make a number of experiments on the effect of enormous pressure on wood sent to great depths in the sea, in augmenting its specific gravity, by impregnation with sea-water. In these experiments, however, some of the water was observed to escape out of the wood, on its being removed from pressure, by the expansion of the compressed air contained in its pores,—a circumstance that prevented me from ascertaining the highest degree of impregnation of which the wood was susceptible. A mode of obviating this inconvenience occurred to me during my last voyage to the polar seas; and this mode also promised to shew to what extent, and under what degrees of pressure, sea-water might be forced through the pores of wood. Not having any metallic vessel suited for the purpose, I employed a strong wine-bottle. I ground the inside of the neck (for the cork) perfectly circular, by means of a cone of wood with sand and water, and reduced it to such a form that a piece of wood, in the form of a frustum of a cone, fitted the neck through the extent of an inch in length, and formed a perfectly air-tight plug. This plug was of very dry ash, and two inches in length. It had a square head, of somewhat greater diameter than the rest of the plug, so that the cone terminated by a kind of shoulder, touching the extremity of the neck of the bottle, to prevent the pressure from thrusting it farther in, and bursting the glass. The neck of the bottle being now heated, the plug, first coated with sealing-wax, was introduced, and, the heat being sufficient to render the wax fluid, it was worked down to the shoulder. The plug and the glass being thus intimately united by a thin intermediate coat of sealing-wax, there could be no doubt that it was perfectly tight.

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* Since I received the above paper from Mr Brooke, I have examined the *Radiated Zeolite*, and find it to differ by the most palpable optical characters from the *Foliated Zeolite* which I had examined in 1817. See *Phil. Trans.* 1818, p. 230. —D. B.

† Read before the Wernerian Natural History Society, 17th Nov. 182[illegible].

In this state, the bottle was sent to the depth of 125 fathoms, and, after remaining a quarter of an hour, was hauled up. About two ounces of water were found to have penetrated the pores of the wood. The bottle unopened was then sunk a second time to the same depth, and a small additional quantity of water was found to have entered within the bottle, at this second sinking.

Now, by this process, I expected, that on pressure being applied to one end only of the wood, instead of every part, as in my former experiments, the flow of water through the pores would force all the air contained in the wood into the bottle, and not confine it by compression, as had before been the case; and in this way I expected that a much higher degree of impregnation would be obtained.

Before examining the plug, I sank the bottle to the depth of 2928 feet; but here the pressure unfortunately being too great for the strength of the glass, the bottle burst, and only the ring of the neck encompassing the plug came up. The result was as follows:

Before immersion, the piece of wood weighed	207	grains.
After the experiment,	315	
Quantity of water absorbed,	108	
Weight in the air after immersion,	315	grains.
Weight of the plug in fresh-water (temp. 40°),	21½	
Weight of an equal bulk of water,	293½	grains.

Hence, specific gravity of the wood, after immersion, 1.073.

As I apprehended that the portion of the plug through which the water had made its way into the bottle, would be more impregnated than the rest, from the expulsion of the air into the bottle, I cut away the projecting sides and corners, and formed the central part into a cylinder. But the specific gravity of this was less than that of the whole, being only 1.032; and the extremity that was in the bottle was lightest of all. This effect I attributed to the want of expansion in this part, occasioned by the strength of the ring of the bottle by which it was compressed, thus preventing it on the lower part from receiving its due share of moisture. On splitting the wood, it was found to be wet throughout its substance.

I next attempted the filtration of water through the pores of a cylindrical piece of mahogany 4½ inches in length. In this experiment, I employed a strong oblong vessel of copper, kindly furnished me by Captain Manby, (who, with his usual public spirit, accompanied me on the voyage, with a view of trying an apparatus for increasing the facilities and diminishing the dangers of capturing the whale). This vessel, with the mahogany screwed into the neck, was sent to the bottom, where the depth was 5040 feet, and allowed to remain an hour and a half. But the enormous pressure to which it was subjected, being about fifty tons, (a ton *per* square inch), crushed the vessel, though every part was an arch, into an irregular flat form, and tore the copper in four different places. Thus, the principal design of the experiment being frustrated, I could only ascertain the quantity of impregnation. The weight of the mahogany, when dry, was 155 grains; the weight gained in the experiment 90 grains. Increase of bulk equal to 3 grains of water.

II. *On the Fogs to which the Polar Seas are subject.*

The great prevalence of foggy weather in the polar seas, during the summer months, is a fact which, though well known, has not, that I am aware of, been explained. In the present year (1821), from the 11th of July until the 21st of August, we only had three days of clear weather. During this interval, we navigated a sea embarrassed with an accumulated quantity of ice; the whole of the ice that so remarkably disappeared in the years 1817 and 1818 having been replaced, and a body above 240 miles in width, having collected on the eastern coast of Greenland. As the fog to which the icy seas are subject, frequently rests on the surface of the water, and extends only perhaps to the height of 150 to 200 feet, the sky above being often perfectly clear, it occurred to me, that the cause of these low fogs might be found, perhaps, in the temperature: that the cold, during such fogs, might be greater at the surface than at considerable elevations, though the contrary is usually the case. Some observations made on the 23d July, during a very thick fog, with a clear sky and bright sunshine above, seemed to confirm this opinion.

The temperature about 11 A. M. at the mast-head, 100 feet above the level of the sea, was 35°; on the level of the deck, by the same thermometer, 33¾°; near the water's edge 34°; and of the water at the surface 34°. Hence, it would appear, that the fog is occasioned by the damp air, near the surface, becoming chilled by contact with, or radiations from, the ice: for, at other seasons, I have almost invariably found the temperature aloft two or three degrees lower than at the surface; while in fogs with a clear air above, it seems to be higher.

Art. XXI.—*Account of the Volcano de Taal, in Luçon, one of the Philippine Islands.* By Dr A. Von Chamisso [*].

We had an opportunity to make only one excursion, of eight days, into the interior, to Taal, and the volcano, of the same name, in the Laguna de Bonborig. The military escort accompanying us, which was a mark of Spanish pomp, was very troublesome, and increased the expences of a journey where only a guide would have been requisite among the mild and hospital Tagalese. The Island of Luçon is every where high and mountainous; the highest summits do not seem, however, to exceed the woody region. Three volcanoes rise from it: first, in the north, the Aringuay, in the territory of the Ygorrotes, in the province of Ilocos, which, on the 4th of January 1641, broke out at the same time with the volcano of Iolo, and the Sanguil, in the south of Magindanao, on which occasion this island presented one of the most terrible scenes recorded in history [†]; the noise was heard on the continent of Cochin-China. Secondly, the volcano de Taal, which particularly threatens the capital, from which it is distant a day's journey; and, lastly, the far-seen Mayon, near the Embocadera de San Bernardino, between Albay and Camarines.

Gold, iron, and copper-mines, which are very rich, but neglected, shew that there are other mountains as well as volcanic ones. On the way we went, we saw no other than volcanic tuff, consisting of ashes, pumice-stones, and dross; and, in Manilla, Cavite, Taal, Balayan, &c., no other stone for building but this same tuff and calcareous reef-stone, procured from the sea. The granite, used in Manilla for building, is brought here as ballast, from the coast of China.

As you go from Cavite, southward towards Taal, the land insensibly and gradually rises till you reach the eminences on the other side, which are rugged and steep, and from which you may overlook, at your feet, the Laguna de Bonborig, and the large smoking crater, which forms in it a dreary, naked island.

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[*] From Kotzebue's *Voyage of Discovery*, vol. iii. p. 52.

[†] The Journals of Manilla mention the destructive earthquakes, in the year 1645 and 1618.

The lake (the Laguna) is about six German miles in circumference; it empties itself into the Chinese sea by an outlet, navigable now only for small boats, though formerly it could carry larger vessels; it runs with great rapidity, and the length of its course is above a German mile. Since the devastation in 1754, Taal has been removed to its mouth.

The water in the Laguna is brackish; but it is, however, drinkable. In the middle it is reported to be unfathomable. It is said to be full of sharks and caymans, of which, however, we saw none.

As we were embarking from the Laguna for the island, the Tagalese exhorted us to look round us in this haunted place, but to keep silence, and not to irritate the spirit by any incautious, or inconsiderate word. The volcano, they said, showed symptoms of displeasure whenever a Spaniard visited it, and was indifferent only to the natives.

The island is nothing but a mass of ashes and scoriæ, which has fallen in itself, and formed the wide irregular crater, which creates so much terror. It does not appear that lava has ever flowed out of it. From the bank, where a little grass grows in scanty spots, and where some cattle are kept to pasture, you climb, on the east side, up a bare and steep ascent, and, in about a quarter of an hour, reach the edge, from which you look down into the abyss as into the area of an extensive circus. A pool of yellow, sulphureous water, occupies about two-thirds of the bottom. Its level seems to be the same as that of the Laguna. On the southern edge of this pool are several hills of sulphur, which are slowly burning. Towards the south and east of it, a narrower crater is beginning to form itself in the interior of the great crater. The arch which it makes surrounds, like the *moraine* of a glazier, the burning hills by which it is produced, and rests with both its ends on the pool. The pool boils, from time to time, at the foot of the burning hills.

You can clearly distinguish, in the internal wall of the crater, the situation of the differently coloured scoriæ of which it consists. Smoke ascends from some points of it.

We observed from the place where we made a drawing of the crater *, a place on the opposite side of it, where a fall into the interior seemed to afford a slope, from which it might be possible to descend to the bottom. It cost us much time and trouble to gain this point, as we found the sharp and pointed edge on which we walked, in many places impassible, and were frequently obliged to descend on the outside almost to the bank. Being under the wind of the fire, we were but slightly incommoded by the sulphureous exhalations.

The place just mentioned is that on which, during the last eruptions, the water poured that was thrown up. We attempted to descend into several clefts, but were ultimately obliged to abandon our intention, after we had reached about two-thirds of the depth. We were not provided in Taal with the cords we required, and by the assistance of which we might probably have descended the perpendicular wall of several fathoms high, which first presented itself to us, without being able to reach the bottom, as the precipice became always steeper the farther we descended. We found, in this neighbourhood, the ground covered with Plumose Alum. The time was too short to permit us to visit other hills. The other craters are at the foot of the principal crater.

The most terrible eruption of the Volcano de Taal was in the year 1754. Its desolating progress is circumstantially related in the twelfth chapter of the thirteenth part of the history by Fr. Juan de la Conception. The mountain was tranquil after the former eruptions, (the last took place in the year 1716,) and sulphur was obtained from the apparently extinguished crater. It began to smoke anew in the beginning of August; and, on the 7th, flames were seen, and the earth trembled. The consternation increased from the 3d of November to the 12th of December; ashes, sand, mud, fire, and water were thrown up. Darkness, hurricanes, thunder and lightning, subterraneous roarings, and long-protracted, violent, and repeated earthquakes, alternated in frightful succession. Taal,

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* This drawing of the Crater will be found in the *Voyage Pittoresque*, which M. Choris (the draughtsman to the expedition) is about to publish at Paris, under the patronage of Count Romanzoff. This beautiful and faithful gallery of our voyage will greatly illustrate our observations and remarks. *App.* vol. iii. p. 142.

lying at that time on the banks of the Laguna, and several villages, were totally ruined and overthrown. The mouth of the volcano was too confined for such eruptions; it widened considerably, and a second opened, which likewise threw up fire and mud. Nay, even more, the fire broke out in several places in the Laguna, at a considerable depth below the surface of the water, which boiled up. The earth opened in many places, and a deep gulf yawned particularly wide, extending far in the direction to Calanbong. The mountain continued to smoke a long time. There have since been eruptions, though with decreasing violence.

Art. XXII.—*On the Ancient History of Leguminous Fruits.* By Professor Link. (Continued from Vol. V. p. 369.)

On Plants used as Fodder.

By Plants used as Fodder, we mean those plants which are cut for feeding cattle, before the seed is ripe. Their cultivation belongs to the recent arts of agriculture, and came long after the cultivation of the species of grain, and of the leguminous fruits.

It was during the preceding century that attempts were first made to cultivate the species of Grasses in prepared meadows. At first attempts were made only with some grasses, by degrees others were tried, and the love of gain which came into play during this trade in seeds, recommended so many species for cultivation, that contempt of the whole was repeatedly excited. *Avena elatior, Lolium perenne, Holcus lanatus, Poa aquatica, Phleum pratense, Alopecurus pratensis, Avena flavescens, Bromus giganteus, Elymus sibiricus, Agrostis alba,* have been cultivated with more or less advantage.

The culture of *Trifolium pratense* was quite unknown to the ancients; they do not even once mention this plant in its wild state, unless it be concealed under the name *Lotus,* as the common people at present call all plants with triple leaves Clover. But all botanical writers of the middle ages mention clover as a plant used for fodder, and it must have been early cultivated.

It grows wild only on cold soils, and never where the *Aloë* blossoms in the hedges; its culture must therefore have been found out by the northern nations. As little do we find any traces among the ancients that another species of clover, *Hedysarum coronarium,* which is now a common article of fodder in Italy, or the *Hedysarum Onobrychis,* were cultivated.

Among the plants used as fodder by the ancients, is ranked the *Cytisus,* and on no plant of antiquity has so much been written as this. In 1731, there appeared at London "A Dissertation on the Cytisus of the Ancients," by Stephen Switzer, with which I am not acquainted. Afterwards it was noticed by Miller in his Gardeners' Dictionary, by Voss on the Georgics of Virgil, by Schneider on Columella, and by Sprengel in the treatise "De Antiquitatibus Botanicis." Voss and Sprengel, like the more ancient botanists, consider the *Cytisus* as *Medicago arborea*; Schneider as a *Cytisus* of the moderns; and Miller, contrary to all testimonies, as no shrub at all. This contrariety deserves to be more particularly examined in another respect.

Aristotle says (Hist. Anim. l. iii. c. 18. § 8.), the *Cytisus* ever eases the milk of cows, and only hurts them when it is in blossom. Perhaps this passage gave the first opportunity of recommending the *Cytisus* as fodder. Theophrastus only mentions the *Cytisus* in passing, (Hist. Pl. l. i. c. 6.); he ascribes to it a very hard wood, even in the inner parts of the stem,—a circumstance which suits very well with *Medicago arborea;* but he says nothing at all as to its cultivation for fodder. In the time of the school of Alexandria, there appeared the work of Aristarchus on the *Cytisus,* to whom Democritus and others succeeded. *Cynthos,* one of the Cyclades, was celebrated for its excellent cheese: the *cytisus* grew there in great abundance; the excellence of the cheese was ascribed to this, and along with the praises of the *cytisus,* its cultivation as a fodder plant was recommended. It is probable that this *cytisus* was the *Medicago arborea.* Besides Theophrastus, its hard wood is mentioned by Pliny, (l. xvi. c. 38. 40.); and *Cytisus laburnum, alpinus,* the wood of which is not less hard, have bitter leaves, which no animal eats. But the cultivation of the *cytisus* seems to have been very limited and transient. Pliny says (l. 13. c. 24.), *Invenitur hic frutex in Cythno insula, inde translatus in omnes Cyclades, mox in urbes*

Græcas magno casei proventu; propter quod maxime miror rarum esse in Italia. Dioscorides describes (l. iv. c. 113.) the *cytisus* as a whitish shrub, like the *Rhamnus*, with branches an ell long, with leaves like those of *Fœnum Græcum*, or λῶτος τρίφυλλος, only smaller, and having a larger middle row; which leaves being rubbed, give out a smell like *Brassica Eruca*, and taste like green chick-pease. This suits *Medicago arborea* extremely well. He adds, some plant it for the sake of bees. There is thus not a word about its cultivation as fodder, which on other occasions Dioscorides did not use to overlook: he even separates it entirely from such plants, and treats of it in another place, among the shrubs. Varro only mentions the *cytisus* incidentally among the fodder plants (l. i. c. 23. § 3., l. ii c. 1 § 26 l. ii. c. 2. § 28.), and always along with *medica.* He also says, that two Spaniards, brothers, had planted it for the sake of bees (l. iii. c. 16. § 14.), and by that means became rich. But Columella distinguishes, in regard to bees, between the *Cytisus suæ spontis* and *Cytisus sativa* (l. ix. c. 4.); and especially in Spain, but also in Italy, there are so many species of *Cytisus* and *Spartium*, which afford the materials of honey to the bees, that they might easily be used instead of the true *cytisus* Columella speaks circumstantially of the cultivation of *cytisus*, but not where he is speaking of plants for fodder, but of nurseries, and says, (l. v. c. 11.), *At priusquam finem libri faciamus, de cytiso dicere tempestivum est.* Then follows an entire chapter on the culture of *cytisus*, which seems, however, to have been borrowed from the Greek of Andromachus. This is probable from comparing it with the notices in Pliny, who follows Aristomachus in his own account, but, as usual, often after a hasty and incorrect perusal. The Geoponica mentions the *cytisus* only incidentally, and not as fodder (l. x. c. 3. § 8., l. xiv. c. 16. § 8., l. xv. c. 2. § 6.); only (l. iii. c. 1. § 8.) it is said the *cytisus* should be cut green in January; which direction is taken ἐκ τοῦ Βαῤῥῶνος καὶ τῶν Κυντιλιῶν, and from some Roman writers, who doubtless had their information from Aristomachus, since the time of the year which is mentioned agrees better with the climate of Egypt than of Rome. We also find (l. xvii. c. 8. § 1.) the account of Didymus, that milch cows should be fed with *Cytisus* or *Medica*, but that it should be thrown to them but occasionally. There is, therefore, no proof, that among the ancients the *cytisus* was much cultivated as fodder; and the proposal of Aristomachus seems to have met with the same fate, which has attended so many proposals of our modern learned economists. Although the learned poet at the court of the Ptolemies, and his imitator Virgil, frequently speak in their poems of the *cytisus*, it does not follow that the plant was generally cultivated.

A very ancient fodder is the *Herba medica*. Theophrastus mentions it, and says manure injures it, (Hist Pl. l. viii. c. 7. § 7. ed. Schn.) Dioscorides (l. ii. c. 177.) describes it as the τρίφυλλον (*Psoralea bituminosa*), but with small leaves, seeds resembling those of lentils, and twisted pods. The latter mark, which is an essential one, is wanting in our editions, but there is a *hiatus*, and in the Arabian translations the words are found. He adds, that the plant is cultivated for fodder. This exactly suits the *Medicago sativa*, the Lucern. What Columella says (l. ii. c. 11.) of its culture, and of its lasting for ten years, likewise agrees with this. Of the name, Pliny says, (l. xviii. c. 16.): *Medica externa etiam Græciæ, et a Medis advecta per bella Persarum quæ Darius intulit.* The lucern is not a native of Europe, for it only grows wild where it is now cultivated, or formerly had been. It also is easily frozen in cold climates.

Of the Vetch, the *Trigonella Fœnum Græcum* and the *Ervilia* *, I have already spoken. Pliny has explained what the ancients called *farrago* and *ocymum*, (l. xviii. c. 16.) The former consists of beer or barley sowed along with vetches; the latter of a mixture of beans, vetches, *Ervilia* and *Avena Græca, cui non cadit semen*. What this *Avena Græca* is, we cannot exactly determine. According to Varro, this mixture has the *ocymum* from ὠχυς, moist, because it grows rapidly. But in Pliny's time, *ocymum* was altogether unknown. An improved husbandry had done away with the mixed fodder.

Grains and Culinary Plants.

Most of the species of grain which we grow in Europe are from foreign countries, and are not natives of Europe. On the other hand, most of the garden plants and greens are natives of Europe, and have been transplanted to other parts of the world.

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* Vicia ervilia, Ervum ervilia, *Linn.*

The west has thus in some measure repaid to the east what it received from it, and it has thus obtained a share in the promotion of human happiness. Only some kitchen plants, those of the cucumber kind, come from warmer regions; and the leek species have an unknown native country.

The Cabbage (*Brassica oleracea*) was very early known. Pythagoras wrote respecting its healing powers, as Pliny informs us, (l. xx. c. 9.); and although this piece of information, like many others attributed to Pythagoras, may be without foundation, it yet shews that the use of the cabbage was considered as very ancient. In the Homeric writings, perhaps from accident, there is no mention of the cabbage. But, at a later period, it is frequently mentioned by Aristophanes. The old Greeks named the cabbage ῥάφανος: afterwards the name of the curled variety, κράμβη, was given to the whole species. The Scholiast on the Plutus of Aristophanes says distinctly, (ed. Brunk. p. 544.), that which the ancients called ῥάφανος is now called κράμβη; and Athenæus explains ῥάφανος by κράμβη, (Deipnosoph. l. ix. c. 9.) There is, therefore, no reason for explaining ῥάφανος by *radish* with Theophrastus, as Schneider has justly remarked. Although the ancients have not exactly described the cabbage, yet their accounts of its varieties, the manner of cultivating it, and even the name (*caulis*), are sufficiently distinctive of this plant. Theophrastus, Cato, Pliny, and Athenæus, speak of the varieties of cabbage in such a manner, that we are able to recognise several of the varieties which are still known. The curled cabbage is called σελινούσιος, because it is curled like the curled parsley; and this first had the name κράμβη. The white cabbage was also known to the ancients, as is evident from the description of the head (*caput*) in Pliny. But I find no traces of cauliflower, because the *cyma*, which is understood to denote it, is a species of sprat, and Prosper Alpinus speaks of cauliflower in Egypt as a new discovery. The ancients blanched the flower-stalks, by binding the leaves together, and then they ate them. They also speak of a cabbage on the sea-shores, which has round leaves, and is of a sharp taste; probably they mean the wild cabbage, not *Br. arctica*, which is shrubby. Cabbage grows wild on the sea-coasts of England in several places, and Sibthorp found it on the coasts of Greece. It is singular that it grows wild only in such different regions; and it is very probable, that it formerly grew wild on other coasts of Europe, but was gradually extirpated by the cattle. The culture of sea-cabbage (*Crambe maritima*), a plant which grows wild on many of the coasts of Northern Europe, is entirely new, and has not yet become general in England. In China a peculiar species of cabbage is cultivated, called by Barrow *Brassica orientalis*, which, however, ought not to be confounded with *Brassica orientalis*, Lin.

Theophrastus places three garden-plants together, (Hist. Pl. l. i. c. 14. § 2. ed. Schneid.), βλίτον, ἀνδραφαξις, ῥάφανος. To the second he ascribes a straight descending root, from which all the other roots come, (L. ii. c. 2.) According to Dioscorides, (l. ii. c. 145.), some call it χρυσολάχανον: the blade is eaten dressed, it is blanched. Aristophanus mentions it. The Romans translated ἀνδραφαξις by *Atriplex*, (Plin. Hist. Nat. l. xx. c. 30.); but they afford few means of enabling us to ascertain it more correctly. In general, their *Atriplex* is considered as an *Atriplex hortensis*, and there is nothing against the idea, but nothing that confirms it. *Atriplex hortensis* was found by the elder Gmelin growing wild in Southern Siberia. The βλιτον is generally mentioned to have been the *Amaranthus blitum*. The notices of the ancients, of Pliny, Dioscorides, and Galen, are so short, and so little descriptive, that the opinion above stated rests merely on tradition. Formerly, this plant was more generally eaten than at present. In Portugal, the greatest number of different species of amaranths (not *Am. blitum*) were eaten under the name of *Bredos*, which, from the usual practice of this language of changing *l*, after a consonant in the beginning of a word, into *r*, as also by the frequent change of *i* into *e*, and of *t* into *d*, has doubtless arisen from *Blitum*. *A. mangostanus* and *gangeticus* are the most common plants in Northern India. Probably the ancients did not even eat *A. blitum*, but *A. albus*, and perhaps some other species, which are more tender than *A. blitum*, and are more common in the south of Europe.

Regarding Spinage (*Spinacia oleracea*), Beckman (Hist. of Inventions, iv. 116.) has instituted some such investigation as might be expected from this industrious scholar. He has shewn that no trace of this plant is found among the ancients, but that, according to Du Fresne's *Glossary*, Spinage is first mentioned in the middle ages. I add to this, that among the Arabians Spinage was well known, although they did not reckon it worth their while to describe it, as appears from Ebn Baitar. Yet the name *Spinachia* seems to be the original, for the Arabian name has not the appearance of an original Arabic word. The Spanish word *Kraut*, which is quoted by some authors, is doubtless a corruption of the Arabic word, which is written *Hospanach* and *Hispanach*. The native country of spinage is unknown. But Marshal of Biberstein found a nearly related species, *Sp. tetrandra*, growing wild in eastern Armenia, which is also eaten by the natives; and he thinks our *Sp. oleracea* is merely a variety of it; a very likely supposition.

A garden-vegetable, well known to the ancients, was the *Lapathum*, and there is no doubt that it is the *Rumex patientia.* Dioscorides describes several species of *Lapathum*, (l. ii. c. 140. 141.), but it is difficult to deduce any thing from his descriptions. Some expressions of Theophrastus (l. vii. c. 2. s. 7.) are characteristic; those which relate to the size and strength of the root, as we see in *Rumex patientia.* The plant grows wild on the elevated meadows of middle and southern Europe. Thus says Horace, *Herba lapathi prata amantis.* Pliny asserts that the wild *Lapathum* is better than the cultivated, and always contains more acid. Formerly *Rumex patientia* was much eaten as greens in Germany, and to this day it is occasionally cultivated as greens, under the name of English Spinage. The name *Patientia* is derived from the French word *patience*, because it is eaten at a time of the year when there are few greens, and people are forced to make use of this. Under the species of *Lapathum*, Dioscorides also mentions the ὄξαλις, or ἀνάξυρις. Our Sorrel (*Rumex acetosa*) cannot be this plant, for it is described as being very low; probably it is the *Rumex scutatus*, the Garden-sorrel, a plant which is very common in the whole of southern or central Europe.

Θριδακίνη, or Θρίδαξ, *Lactuca*, if we judge by the name, which remains unchanged in all the modern tongues, is our *Lactuca sativa.* The plant was too well known to be particularly described. What the ancients say of the effects of *Lactuca*, does not oppose the idea, that our *Lactuca* was the same with the

Lactuca of the ancients. Even the milky juice, whence the name *Lactuca,* points out this identity. But some related plants seem also to have received this name. The *Lactuca* with thistle-leaves, mentioned by Theophrastus (H. Pl. l. vii. c. 4. s. 5.), is probably a curled variety; but the broad-stalked, from the stems of which garden-gates were made, was, although a monstrous production (*caule fasciato*), yet a related species. Under the name Lactuca *sativa*, there are at present two species included. Where the *Lactuca* grows wild, is quite unknown. The wild *Lactuca* of the ancients (Dioscorid. l. xxvi. c. 61.) is *Lactuca virosa.* The *Lactuca* was known in very early times. The ancients seem to have eaten a great many plants of the natural order *Semiflosculosæ*, which Theophrastus reckons up under the names κιχώρη, ἀφάκη, ἀνδρυάλα, ὑποχοιρὶς, ἠριγέρων, and which were called κιχωριώδη, from the similarity of their leaves. Dioscorides cites ἠριγέρων (l. iv. c. 97.), which is translated *Senecio,* and the description of which agrees pretty well with *Senecio vulgaris*, or some related species. But this plant is not eatable. Dioscorides also does not speak of its use as greens, and does not cite this plant along with the other plants used as greens. Galen says nothing whatever respecting it. Probably the word had received a different meaning in later times. Ὑποχοιρὶς is compared by Theophrastus with κιχώριον, (Hist. Pl. l. vii. c. 11. s. 4); but it is said to be smoother, softer to the eye (ἡμερωτέρα τῇ προσόψει), and sweeter. The comparison between it and *Cichorium* shews, that the plants which have been taken for it, *Hyoseris*, *Hedypnois*, *Hypochæris*, Linn. do not belong to it. Ἀνδρυάλα is mentioned in this passage alone. Ἀφάκη is described (c. 11. s. 4.) as not eatable. The word is used among the names of garden-greens, and among the *Cichoraceæ* by Theophrastus only, and by Pliny, who translates these passages. Bauhin does not comprehend why Theophrastus quotes this plant among the garden-greens, and yet afterwards says it is not eatable. If we insert the καὶ, which has occasioned so much perplexity to Schneider, the passage (l. vii. c. 4. s. 1.) then intimates that these plants were also named λάχανα, simply on account of their resemblance to *Cichorium*. It is quite in vain to endeavour to ascertain these plants, especially as later writers do not mention many of them. To me they seem partly to denote only varieties of Succory or Endive, which itself may be only a variety of Succory. Κιχωρίον (Theophrast. Hist. Pl. l. vii. c. 11. s. 3.), which is also called σέρις (Dioscor. l. ii. c. 160.), and by the Latins *Intybus* (Galen. de Aliment. Facultat. l. i.), is so described by the ancients, that the description suits completely our Succory or Endive. (See particularly Theophrast. l. vii. c. 8. s. 3.) Willdenow [illegible] Endive grows wild in the East Indies, because [illegible] from thence; but it is much to be doubted whether [illegible] same species. Succory is well known as a wild plant [illegible] the whole of Europe.

There was a plant very common, and from the earliest times cultivated by the Greeks and Romans, the use of which has been quite lost since the middle ages: it is the *Malva* of the Romans, μαλάχη of the Greeks. That the ancients, by the word μαλάχη, which word is used by Hesiod, or μολόχη, meant one of the *Malvaceæ*, is evident, from the excellent description of the fruit of Phanias in Athenæus (l. ii. c. 52.), to which the Malva is well known to have been related. But what plants of this genus were eaten, is not easily determined. The ancients distinguished between the wild Malva and the cultivated, (Dioscor. l. ii. c. 144.); and Theophrastus says, respecting the latter, that it is almost shrubby, (Hist. Pl. l. i. c. 5.) Hence Sprengel also considers this plant to have been *Lavatera arborea*, and Sibthorp considers it as *Alcea rosea*, which commonly grows wild in Greece. But the leaves of these plants are very hard. Probably another large, but tender, species of the Malva is designated by this name, perhaps *Malva crispa*, a plant which is suspected to be a native of the East, having tender leaves, and a stem which is often very high. It does not follow from the writings of the ancients, that the Malva grows wild in Greece, because what they call wild and cultivated plants, are often different species, as we have seen above respecting *Lactuca*. But the ancients had also another smaller species (Plin. l. xx. c. 21. Afric. l. iii. c. 8.), which is probably *M. rotundifolia*. They made this plant savoury with some additions to it.

The Beet (*Beta rubra*, and *Cicla*) was well known to the ancients, and respecting its designation there is no doubt. The Romans named it *Beta*, the Greeks τεύτλιον, τεῦτλις, or σεύτλιον. Theophrastus distinguishes two species (Hist. Pl. l. vii. c. 4. § 4.), the black, which we called the red, and the white. Instead of these, the Romans distinguished between winter and summer beet, (Plin. l. xix. c. 8.) Athenæus has four species of beet (l. ix. c. 11.), σπαστὸν, καυλῶτον, λευκὸν, πανδημὸν. The two latter have been determined, the other two remain still doubtful. Καυλῶτον was probably the same large variety, of which Theophrastus speaks as an woody plant, (Hist. Pl. l. i. c. 2. s. 3. Schn.) Linnæus has placed the native country of the white beet in Portugal, on the banks of the Tagus; and the native country of the red variety in the south of Europe generally. The former locality is not altogether incorrect: there grows in that country an intermediate species between the red and white beet, which, however, may well be reckoned the original species, and which probably grows in several places in the south of Europe.

Ανδραχνη is not described by Theophrastus, Dioscorides, and Galen; it is only named as a garden-vegetable. The word has been translated *portulaca*, perhaps merely because Dioscorides says of the wild Andrachne, it has thicker leaves. According to the properties that have been ascribed to it, it has a tough mucilage. The plant has not been ascertained. A shrub also bears the same name.

Στρυχνὸς belongs to the garden-greens. According to Theophrastus, it is eaten raw; whilst, on the other hand, Malva and others are dressed, (Hist. Pl. l. vii. c. 7. § 2.) The passages, which have been interpreted of an edible fruit, have been corrected by Schneider, (l. vii. c. 15. § 3.) The fruit resembles a grape, says Theophrastus. We must distinguish it from other plants of similar names, (l. ix. c. 12. § 5.) Dioscorides describes the plant as a small shrub, with blackish leaves, a round, at first green, afterwards red or black, fruit. Galen considers this plant to be very astringent: it is seldom eaten. Many editors consider this plant to be a *physalis;* but the author was not speaking of edible fruits. Neither can I venture to determine this plant. *Solanum nigrum*, which has been suspected of being it, is not eaten raw.

The *Nettle*, ἀκαλύφη, according to Galen, was eaten as greens, as happens at this day in many countries, where it is dressed in spring, mixed with other herbs.

(To be concluded in next Number.)

ART. XXIII.—*On the Arseniates of Copper.* By H. J. BROOKE, Esq. F. R. S. Lond. M. G S. &c. &c. Communicated by the Author.

THE following communication is occasioned by a recent examination of the crystalline forms of the Arseniates of Copper. This examination has led me to differ from the Count de Bournon, in regard to the primary forms of the several varieties of that substance, and has induced me to adopt such others as appear more compatible with the secondary forms under which those varieties usually present themselves.

The Count has divided the arseniates of copper into five species.

1. An obtuse octahedron, with a rectangular base.
2. A hexagonal prism,
3. A right rhombic prism of 94° and 86°.
4. A right prism, whose bases are equilateral triangles.
5. Fibrous.

The *First species* may possibly be an octahedron, with a rectangular base. There are, however, striæ or two planes of each pyramid of some of the crystals, as in Plate VI. Fig. 1., which seem to indicate an oblique rhombic prism as the primary form; in which case, the octahedron may be conceived to be produced by a truncation of two of the solid angles of the prism, as in Fig. 2. I have not been able to cleave the crystals in any other direction than parallel to one plane of the pyramid; nor have I seen any variety of form among those I have examined, from which the primary form might, with greater probability, be inferred. The natural planes of the crystals do not afford sufficiently good reflections to give their inclination with accuracy. They may be said, however, to measure, over the edges of the base, about 73° 30′, and 61° 30′, which would give the ratios of the axis of the octahedron, and the edges of the rectangular base, nearly as 3, 4, and 5.

The primary form of the *Second species* appears to be an acute rhomboid of nearly 68° 53′, by measurement; but, by inference, from C on P, Fig. 4., measuring 107° 30′, its angle would be 68° 38′. The form under which the crystals occur, is that modification in which the summits of the rhomboid are very deeply truncated, as shewn by the dotted lines in Fig. 3., and Fig. 4. There are cleavages parallel to the primary planes P, P′ P″;

but the crystals are most fissile in a direction perpendicular to the axis of the rhomboid; that is, parallel to the terminal planes of the hexagonal crystals.

The replacement of the lateral edges of the primary rhomboid, as in Fig. 5., produces the planes of the supposed hexagonal prism.

Several other modifications of the primary rhomboid occur, One of which produces the obtuse rhomboid, shewn in Fig. 5., *a* on *b* measuring about 179° 30'. The planes are brilliant, and the edges distinct; so that I cannot doubt the existence of the form. Yet the decrement which would produce it, is so extraordinary, being several hundred molecules in height and breadth, that I suppose it may be produced by some other law than that which commonly operates upon those primary forms.

The primary form of the *Third species*, is a right rhombic prism, Fig. 6., of about 111° 45', M on M', and 68° 15', the crystals being usually attached to the matrix by one of the obtuse edges of the prism. The dotted lines in Fig. 6., shew the position of the most common form of the natural crystals, Fig. 7.; by which it appears, that the diedral termination of those crystals consists of two of the primary planes. There is a sufficiently distinct cleavage parallel to the planes M M' and P; but the cleavage planes are very dull. Count Bournon has taken *a* and *b*, Fig. 7., as the primary lateral planes of his rhombic prism; but, as I have not succeeded in cleaving the crystal parallel to those planes, or perpendicular to the axis of the prism, as constituted by those planes, I prefer taking the form I have given as the primary one. If the planes *a* and *b*, which incline at an angle of about 93°, are the result of a decrement by one row on the acute angles of the terminal planes, the height of the prism, Fig. 6. would be to its terminal edge as 15 to 19, very nearly.

The primary form of the *Fourth species*, is an oblique rhombic prism of 56° and 124° nearly,—oblique from the acute angle of the prism, and attached to the matrix, sometimes by the base, and sometimes by the obtuse lateral edges of the prism. The only cleavage I have observed, is parallel to the terminal planes of the prism, in which direction the laminæ separate with great readiness. Fig. 8. shews the primary form, in which the dotted lines mark the modification Fig. 9. This appears something like a triedral prism, where only one summit is seen; but, in those crystals where both summits are visible, the triangular terminations are reversed with respect to each other, as they appear in the figure. Fig. 10. contains some modifications which occur in most of the crystals I have seen, and shews, by dotted lines, the direction in which the crystals are sometimes elongated, when attached to the matrix [illegible]

M on M′,	[illegible] about	56°
M on P,	- -	95°
P on *a*,	- -	80° 30′
P on *d*,	- -	125°

If the prism *a*, be the result of a decrement, by one row on the acute angle of the terminal plane adjacent to the acute solid angle of the prism, the lateral edge will be to the terminal edge as 5 to 2; and the small plane *b*, would result from a decrement, by two rows in height, and three in breadth, on the other acute angle of the summit.

The *Fifth species* of Count Bournon belongs, I believe, to the *Third*, which I have observed to pass into the fibrous variety, through a series of prisms successively diminishing in size.

There being a difference in the results of the analysis of these substances, as given by Klaproth, Vauquelin, and Chenevix, I have been induced to examine them again, and I am inclined to believe, that their composition may be stated as follows, in atoms or proportions:

Obtuse octahedron,	1 Oxide of copper,	1 Arsenic acid,	5 Water.
Acute rhomboid,	2 ———	1 ———	3 ——
Right rhombic prism,	4 ———	2 ———	3 ——
Oblique rhombic prism,	2 ———	1 ———	2 ——

There is some uncertainty in the results obtained, by dissolving the mineral in dilute nitric acid, and apparently saturating the solution with carbonate of potash, which has probably occasioned the results of the published analyses to vary from each other: For, if the carbonate of potash be added, until a precipitate of carbonate of copper begins to appear, which is not re-dissolved, and the arsenic acid be then precipitated by an *excess* of nitrate of lead, a portion of arsenic acid sometimes remains in the solution; and when the excess of lead has been precipitated by sulphate of potash, and carbonate of copper been thrown down by carbonate of potash, the carbonate of copper has sometimes contained a sensible portion of arsenic acid.

I have observed, that arsenic acid, when dissolved in distilled water, does not decompose carbonate of potash.

LONDON,
November 1. 1821.

ART. XXIV.—*Remarks on the Insensibility of the Eye to certain Colours.* By JOHN BUTTER, M. D., F. L. S., M. W. S. &c. &c.; Resident Physician at Plymouth. In a Letter to Dr Brewster.

MY DEAR SIR,

KNOWING how much you have directed your attention to the subject of optics, and that every variation connected with the ordinary phenomena of vision is interesting to you, I transmit, without farther apology, the particulars of the following case, which my friend, Dr Tucker of Ashburton, Devon, has lately made known to me in the instance of his own son: About two years ago, Mr Robert Tucker, who is now aged 19, and the eldest member of a family of four children, discovered that he was unable to distinguish several of the primitive colours from each other. He was employed in making an artificial fly for fishing, intending to have constructed the body of the fly with silk of an *orange* colour, whereas he used that of a *green*. When the error was pointed out to him by his younger brother, he could not believe it, until it was confirmed by other persons. Threads of orange and green silk were then twisted round his finger, and he could not perceive any difference in them, but thought them to be the same coloured thread twisted several times. This circumstance led to a trial of his powers for distinguishing other colours, and the following are the results which have been ascertained, taken correctly by frequent repetition, and confirmed by the trials made in my pres[illegible]. Many of the leading or primitive colours, he neither knows when they are shewn, nor remembers after they have been pointed out to him. Certain colours are confounded with each other. Orange he calls green, and green colours orange; red he considers as brown, and brown as red; blue silk looks to him like pink, and pink of a light blue colour; indigo is described as purple. The seven prismatic colours seen in the Spectrum, are described in the following manner:

Colours.	Colours.
1. Red, mistaken for	Brown.
2. Orange,	Green.
3. Yellow, generally known, but sometimes taken for	Orange.
4. Green, mistaken for	Orange.
5. Blue,	Pink.
6. Indigo.	Purple.
7. Violet,	Purple.

So that the *yellow* colour alone is known to a certainty. The colours were shewn to him on silk, on feathers, and in Syme's book of colours, with uniform result. Red and brown colours appear the same, as well as green and orange, blue and pink, and indigo and purple. With the exception of black or white objects, which he seldom mistakes, all colours are by him divided into three classes, viz.

Class 1st, Includes red and brown.
2d, blue, pink, indigo, violet, and purple.
3d, green and orange colours.

He can generally say, with certainty, to which of these three classes any colour belongs, but he mistakes one colour for another. A difference in the shades of green he can distinguish, though not the green colour itself from the orange. Soldiers' scarlet coats appear red. Grass looks green [*]. The colours of horses are quite unknown to him, except a white or black horse. A bay, a chesnut, and a brown horse, is described of the same colour. The colours of the rainbow or of the Moon, appear nearly the same, being twofold; at least, two distinct colours only are seen, which he calls *yellow* and *blue*. A blue coat, however, he can distinguish from a black, but this circumstance may be owing to the metal buttons in the one coat, and not in the other; and a yellow vest is always known to him. By day, he called carmine red, lake red, and crimson red *purple*, in Werner's book of colours by Syme; but by candle-light this error was detected, and the colours were called *red* with a tinge of *blue*. Black, which is the negation of all colour, could not be distinguished by him from a bottle-green colour, in one instance, though the difference was quite obvious to myself. Black, white, and yellow bodies are, however, recognised with tolerable certainty; though the shades of white, which again is but the beam of all colours, are not distinguishable. The shades of *green* can be distinguished from each other, as already stated, though none of them are known from orange. Duck-green, he called a red, and sap-green an orange colour. If he closed one eye and looked with the other, the results were not altered. His health has been good. This defect has not sprung from disease, it bears no relation to nyctalopia or amaurosis only in its probable seat; it is natural, not morbid.

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[*] It is remarkable that green, which is the softest of colours, and composed of yellow and blue, should be mistaken for orange on every substance except on grass.

Description of Eyes.—Mr R. Tucker's eyes appear to be very well formed, being oblate spheroids with corneæ, neither remarkably convex nor flat. Irides light ash-colour. His vision is exceedingly acute. It has been frequently exemplified in finding bird's nests, in shooting small birds, and in reading minute print at a short or long distance. Light appears to him as light. He sees the forms of surrounding objects like other people at noon-day, in the twilight, and at night. In short, his sight is remarkably good in any light or at any distance. His grandfather, on his mother's side, seems not to have possessed the faculty of distinguishing colours with accuracy.

General Remarks.—Physiologists may speculate in opinion, whether or not this deficiency in the faculty of perceiving colours, as exemplified in the instance of Mr R. Tucker, depended on the eye as the instrument and organ of vision, or on the sensorium to which all impressions made on the retina of the eye are referred, and in which the faculty or power of discriminating colours is supposed to reside. Vision, regarded as a sensation, is only one medium of communication, which the brain or common sensorium has with the external world. The other senses afford other media. If an eye sees objects clearly, distinctly, and quickly, vision cannot be considered defective. The faculty, whatever it may be, wheresoever it resides, of discriminating the differences between different objects, certainly is not confined to the eye. The eye is but an optical instrument, serving to the purposes of vision ; the judgment exercised upon the visual sensations, is an after process, and resides not in the eye. Still, however, the construction of the visual organ, modifies the appearances of objects presented to it. All eyes do not see equally well in the same light. Nevertheless, there is a standard of vision which we call common. A difference in the vision of eyes depends, not unfrequently, on the colours of the iris and tapetum. In Albinos, the iris is red. They cannot see distinctly in the day time, because the red rays of the sun are possibly reflected, while the rest may be absorbed. It is probable that the red rays may be reflected from the iris when most closed, in Albinos, because in them there is a deficiency in the pigmentum nigrum or black coating, which covers the choroid tunic, and which being wanting, allows the rays to be more reflected and less absorbed than they are in human eyes generally. Hence the pupil is almost closed in Albinos. Red, we know, strikes the eyes most forcibly, as it is the least refrangible colour. In optics, it is proved that red bodies reflect the red rays, while they absord the rest, and green colours reflect green rays, and possibly the blue and yellow but absorb the rest. Still, however, the consciousness of colours does not depend on the colour of the iris, because one person having a dark iris, and another a light grey, can distinguish colours equally well ; nor on the tapetum, by the same rule, though the use of this coloured matter in the eye, is not yet well made out. Herbivorous animals, as the ox, are supposed to have the tapetum in their eyes of a greener colour than carnivorous animals, in order to reflect the green colour of the pasturage : but this explanation, given by Monro *primus*, does not hold good, for the hare, whose tapetum is of a brownish chocolate, and the stag, which has a silvery blue tapetum inclining to a violet, is equally herbivorous with the ox. In man and apes, the tapetum is of a brown or blackish colour ; in hares, rabbits, and pigs, it is of a brownish chocolate. The ox has the tapetum of a fine green-gilt colour, changing to a celestial blue ; the horse, goat, and stag of a silvery-blue changing to a violet ; the sheep of a pale gilt green, sometimes bluеish ; the lion, cat, bear, and dolphin, have it of a yellowish-gilt pale ; the dog, wolf, and badger, of a pure white, bordering on blue. The use of the tapetum and of the pigmentum nigrum, can scarcely be said to be known. We can only infer, that the tapetum, if white, might reflect all the rays and absorb none, and if black, as in man, it should absorb all the rays and reflect none. "Il est difficile," says Cuvier, "de soupconner l'usage d'une tache si eclatante dans un lieu si peu visible, Monro et d' autres avant lui, ont cru que le *tapis* du boeuf est vert, pour lui representer plus vivement la couleur de son aliment naturel; mais cette explication ne convient pas aux autres especes." Cuvier, *Leçons d'Anat. Comp.* tom. ii. 402. Birds and fishes may perceive colours as well as animals, though they have no tapetum. The vision of man is regarded the most perfect, and defective vision in old people, is sometimes produced by a deficiency of the black paint. These considerations do not, however, lead us to suppose, that the faculty of distinguishing the harmony of colours depends on the eye, any more than the concord of sounds does on the ear. The eye and the ear can be regarded only as instruments for bringing the sensorium or thinking principle of man and animals acquainted with whatever is visible or audible. The faculty, therefore, must reside elsewhere. Quickness of vision never made a Newton, nor delicacy of hearing a Handel, nor fineness of touch a Reynolds, nor acuteness of smelling a Davy, nor accuracy of taste any philosopher whatever. For all that man sees, hears, touches, smells, and tastes, constitutes only a specific difference in his sensations. These several sensations are compared, judged of, and distinguished from each other, by some internal principle which does not reside in the organs themselves. It is this principle or discriminating faculty of colours which is wanting in Mr R. Tucker. Pressure made on the optic or auditory nerves entering the brain, will paralyse these organs which can neither see nor hear, unless their communication with the brain be preserved. Amaurosis sometimes arises from disease in the brain, and deafness from a similar cause. The brain is the sensitive centre which feels all the sensations of light, sound, odour, and taste. In palsy, the latter is often annulled. In the instance of Mr R. Tucker, there is no evidence whatever, to lead a person to suppose, that defect exists in the functional office of his eyes, for his vision is quick above par. Where, therefore, does the fault lie? His eyes do their office, but the subsequent processes of perceiving, judging of, comparing, and remembering (as confined solely to colours, his other faculties being perfect,) are deficient. We must seek the explanation, therefore, in physiological, and not in optical science, for the phenomena do not depend on the mechanical construction of his eyes. Yours, &c. JOHN BUTTER.

Observations on the preceding Paper. By Dr BREWSTER.

From the facts described in this very interesting paper, Dr Butter has concluded, that Mr R. Tucker's imperfect vision of colours has a *physiological* and not an *optical* origin; and he proceeds in the conclusion of his paper, (which, for obvious reasons [*], we have omitted,) to fortify this conclusion by the statement, that Mr R. Tucker is particularly defective in the "organ of colours."

In giving an account of the case of Mr Dalton, and others, whose eyes have an imperfect perception of colours, Dr Thomas Young has remarked, (in opposition to Mr Dalton's opinion, that the vitreous humour of his own eye is of a deep blue tinge), that "it is much more simple to suppose the absence or paralysis of those fibres of the retina which are calculated to perceive red."

With regard to the existence of fibres in the retina, suited to the perception of different colours, we have no evidence; but it seems quite sufficient for the explanation of the leading facts, to suppose that the retina is insensible to certain colours.

Dr Wollaston, in his interesting paper on sounds inaudible to certain ears [*], has shewn, that ears, both of the young and old, which are perfect with regard to the generality of sounds, may, at the same time, be completely insensible to such as are at one or the other extremity of the scale of musical notes; and I have lately ascertained, that some eyes which perform all the functions of vision in the most perfect manner, are insensible to certain impressions of highly attenuated light, which are quite perceptible to other eyes. Dr Wollaston has given the most satisfactory explanation of this partial insensibility of the tympanum, and I conceive, that the insensibility of some eyes to weak impressions of light, requires no other explanation, than that either from original organisation, or some accidental cause, the retina of one person may be less delicate and less susceptible of luminous impressions than the retina of another, without being accompanied with any diminution of the powers of vision. If a sound ear, therefore, may be deaf to sounds of a certain pitch, without our looking for the cause of this in the form of any part of the brain, why should we appeal to such an uncertain guide for an explanation of the analogous phenomenon of the insensibility of the eye to certain colours?

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[*] We have received various phrenological communications for insertion in this Journal; but independently of the opinion which we entertain of this branch of modern study we could make no apology to our readers for inserting such articles, when we are obliged to omit one half of the papers that are sent to us on subjects of substantial science.

[†] See this *Journal*, vol. iv. p. 158.

ART. XXV.—*On Cryolite*[*]; *a Fragment of a Journal by* Sir CHARLES GIESECKÉ, F.R.S.E., M.R.I.A., M.G.S., &c. and Professor of Mineralogy to the Royal Dublin Society.

TOWARDS the end of September 1806, on returning from my mineralogical excursions around Cape Farewell, and part of the eastern coast of Greenland, I was informed by one of the Greenlanders who accompanied me, that they sometimes found loose pieces of lead (*Akertlok* of the natives) in a frith to the northward of Cape Desolation (*Nunarsoit* of the Greenlanders), but he could not tell me the exact spot. Though the unfavourable season was already advanced so far, and the equinoctial gales had begun blowing so violently as to make it unadvisable to venture upon such a doubtful excursion, yet I resolved to go in search of the place, as we were near to the mouth of the frith in question. The name of the frith is *Arksut*, (Engl. the Leeward): it was divided into two arms; that on the right of the entrance had a south-easterly, that on the left an easterly direction. I steered up the eastern arm about sixteen miles, and put on shore at different places. I already began to despair of finding lead, when I observed, at some distance, but near the shore, a snow-white spot. At first sight, I suspected it might be a small glacier; but considering that no such thing could exist, at this time of the year, so near to the sea, I landed, and I found, to my great astonishment, a bed of Cryolite, the geological situation of which had been hitherto so doubtful.

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[*] I know no name in the system of mineralogy more expressive of the external character and the fusibility of this substance, than that adopted by my deceased friend Dr Abilgard, late Professor in the University of Copenhagen, who was the first who noticed and analysed this substance.

The islands which lie across or shut up, as it were, the mouth of this frith, consist of coarse granular granite. The lofty mountain *Kognekpamiedluæt* (Engl. the clifted rock with the long tail), which rises on the left side of the entrance of the friths, and which is a landmark to the navigator, is composed of the same granite, but with overlying sienite, the felspar of which is beautifully labradoric. This granite continues uninterrupted for eight miles on both sides of the frith of Arksut, when it disappears and alternates with gneiss. This gneiss forms the shores on both sides of the frith for from seven to eight miles, to the spot called *Ivikæt* by the natives, where the cryolite is found. The name *Ivikæt* (from *ivik*, grass,) was given to this place by the Greenlanders, on account of its peculiar fertility. The place was formerly visited by them during the summer season, on account of its being a good place for fishing and drying *Angmaksæt* (*Salmo arcticus*, Lin., the *Lodde* of the Norwegians), but it was deserted twenty years ago on account of the increasing floating ice. Hence it arises, that we owe the first discovery of cryolite to the Greenlanders, who, in finding it to be a soft substance, employed the water-worn rounded fragments as weights on their angling lines. In this shape, the first specimens of cryolite were sent by the Missionaries as an ethnographical curiosity to Copenhagen. It was of course incorrectly stated in some periodical papers, that the cryolite was discovered by me; I only found its geological situation, and I dare say by a mere accident.

The cryolite is found, as I mentioned before, near to the shore, resting immediately upon gneiss. This rock, which here forms the shore of the frith, is under water during the tide, as well as the superincumbent cryolite, and both are very much decomposed, where they are in contact with each other. The gneiss is metalliferous, and intersected by small horizontal and vertical veins of quartz, from the thickness of 1 inch to that of 3 or 4 inches, containing tinstone, accompanied by arsenical pyrites, common iron-pyrites, small particles of wolfram, and lithomarge; the whole bearing a striking resemblance to the tinstone veins in Saxony and Bohemia. The tinstone occurs massive and crystallised in imperfect octahedrons; the arsenical pyrites is partly massive, partly crystallised in oblique four-sided prisms; the iron-pyrites occurs only disseminated.

At a distance of about 120 fathoms from this spot, there is an extensive bed of large quartz crystals, similar to those found near Zinnwald in Bohemia; but they are throughout in a perpendicular position, some of them measuring a foot in length, and from 4 to 5 inches in thickness, containing small imbedded crystals of tinstone, of the above mentioned forms. This bed is intersected by a nearly vertical vein of compact fluor, of the thickness of from 6 to 7 inches. The whole is equally exposed to the tide. The fluor contains no metallic substance, but it is of a singular nature. Its colour is reddish blue, verging towards lavender-blue; the substance is dull, soft, and presents rather blunt-edged indeterminably angular fragments. Its powder is reddish-white. It emits a strongly hepatic smell when rubbed. The common kind of compact fluor occurs along with it.

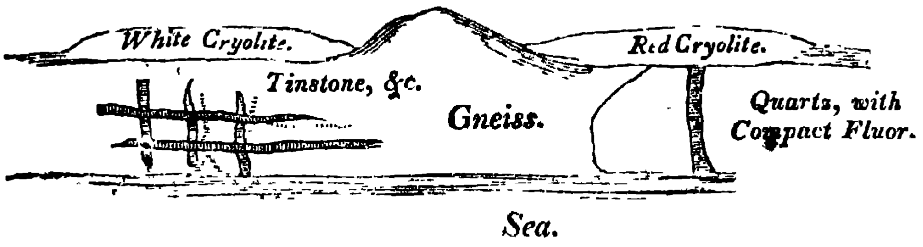
The cryolite rests upon the gneiss, which contains the substances just enumerated, and forms two distinctly different beds, which are nearly of the same dimensions, namely, 10 fathoms in length, and from 5 to 6 in breadth. The purest cryolite is that of a snow-white colour, without any intermixed foreign substance, if I except a few nearly minute spots of galena. Its colour passes gradually into greyish-white, when it approaches to the other bed. The greyish-white variety on the surface very much resembles ice, which has been corroded and grooved by the power of the sun's rays. In these fissures, we sometimes observe the threefold cleavage of this substance beautifully displayed. Fragments of quartz and sparry iron-ore in rhombs sometimes occur in the greyish-white variety.

The other bed is separated from the former by an elevation of the underlying gneiss, and has a very different appearance. The snow-white and greyish-white colour is changed gradually into reddish-white, and passes, in proportion to the quantity of the imbedded metallic substances, into orange-yellow and brownish-red. We find, in the reddish-white variety, quartz crystals and particles of flesh-red felspar; in the orange-yellow and brownish-red varieties, sparry iron-ore, iron-pyrites, copper-pyrites, and galena, occur in great abundance. Sparry iron-ore occurs massive, and in rhomboidal crystals, accumulated in groups of considerable size. Its colour is always dark blackish-brown, and the surface of the crystals partly tarnished, partly decomposed. I found some of the crystals hollow, and some filled with particles of common iron-pyrites: Iron-pyrites occurs generally massive, rarely crystallised in cubes and dodecahedrons. Copper-pyrites occurs only disseminated in galena. The galena of this place has the peculiar property of melting calmly before the blowpipe into a globule, without the least decrepitation. Some fragments are covered with a yellowish-white and greenish-white coating, which, when held to a candle, burns with a blue flame and a sulphureous smell. This kind of galena presents some properties of native lead, as the sulphur appears to be elicited, and the ore reduced by the action of the sea-water or the atmospheric air. Galena occurs here disseminated, massive, but rarely crystallised in perfect cubes, and in cubes truncated on the angles and edges.

This variety of cryolite (I may perhaps call it in a geological view *Metalliferous* Cryolite) was not known in Europe before I visited the coast of Greenland; because, owing to its decomposed state, it was not used for any domestic or economical purpose by the Greenlanders. They preferred the white variety, which, from its colour and greasy appearance, was called by them *Orksoksiksæt*, (from the word *orksok*, blubber,) a substance that has resemblance to blubber.

I could have remained with pleasure during the whole winter on this spot, so alluring to a mineralogist; but I had to provide for twelve human beings who followed me, and who looked more for seals than for minerals. The floating ice pressed upon us in all directions, and it was advisable to get rid of the frith and gain the open sea, as we had to clear 250 miles in a very boisterous season, before we could reach our winter residence.

Geognostic Situation of Cryolite.



ART. XXVI.—*Remarks on the Flora Scotica of* Dr HOOKER.

THE want of a full and accurate description of the vegetable productions found in Scotland, had long been lamented by the botanists of that country. Separated as it is from England, by physical differences not confined to its vegetables alone, Scotland must be allowed an importance among the European countries sufficient to sanction an attempt to elucidate its phytography, and to merit a peculiar Flora, separate from that of the sister kingdom. Whether it has been owing to the deficiency of botanical knowledge among the natives, or of sufficient enterprise or leisure among those qualified to undertake the work, it is not of great importance to determine; but it ought to be more or less mortifying to that people, noted as they are for industry and the cultivation of science, to reflect that the prize of merit in this department must be conferred on foreigners. Lightfoot may be said to have been the only person previous to our own times, who had given any account of our plants worthy of notice. His Flora, admirable as it is, considering the time at which it was compiled, and the limited opportunity of observation which he possessed, has been found defective in many essential points; and besides fulfilling the principal intention of the work, namely, guiding the student to a knowledge of the vegetable productions of the country, has served to show the adept the necessity of a more perfect work, better suited to the improved state of the science, and more capable of gratifying the curiosity of those naturalists who look beyond the mere classification of the works of Divine Wisdom and Beneficence. It was reserved for Dr Hooker, a native of England, and Professor of Botany in the University of Glasgow, to present the public with another and more perfect Flora of Scotland.

A few remarks on this work, which may in part anticipate, and partly lead to observations of a general nature, are now to be offered. The propriety of determining general rules, by which the plan and execution of a work on science are to be examined, may be apparent enough; but in the present case, the practice is not deemed the most eligible, the intention of the writer being merely to point out, in this particular work, the deficiency or completion in the fulfilment of its professed design, in the course of which observations of a less limited nature will be elicited.

The Flora Scotica of Dr Hooker professes to be simply "a Description of Scottish plants, arranged both according to the Artificial and Natural Methods." Viewed in this light only, its merits must be evident to every one tolerably skilled in the science. It not only comprehends a greater number of species than the Flora Scotica of Lightfoot, or the more perfect Flora Britannica of Smith, considering the latter work in regard to its connection with Scotland; but has the superior merit of more accurately defined characters, of a judicious change in the arrangement of genera under their respective classes; of species under their genera, and of the adoption of the numerous improvements in nomenclature, description, and generic and specific discrimination, to which the botanists of our own island have so essentially contributed. Some objections, however, are to be made, even in reference to those points, which will appear in due time. Perhaps, after giving an accurate account of the genera and species, according to the Linnean Artificial method, it might have been sufficient to have conducted the Natural arrangement, which constitutes the second part of the work, in a more compendious manner than that used. And when it is considered that the genera of the Linnean system are, and must be natural *, however the artificial character may be constructed; it cannot but strike us, that in such a work it would be better to arrange the genera under the natural orders, without the unnecessary repetition of generic, much less of specific characters. But allowing that the generic characters in the natural method, might with propriety enough be delineated,

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* Genus omne est naturale, in primordio tale creatum, hinc pro lubitu, et secundum cujuscunque theoriam non proterve discindendum aut conglutinandum.—*Phil. Bot.*

Character naturalis basis est omnium systematum, generum infallibilis custos, omnique systemati possibli et vero applicabilis.—*Phil. Bot.*

as differing in several points from those used in the artificial method to designate the same genera, little doubt is to be entertained about the impropriety of a repetition of specific characters, or even of specific names, they being in no respect different from those used in the artificial method.

The Synoptical Tables of the genera, at the head of each class, are, in general, perspicuous and neat. But it is apprehended that several of them are too intricately methodical for the student; and the predilection for synoptical arrangement, which characterizes the acute Muscologist, is displayed, wherever an opportunity occurs. The Grasses, for example, one of the most perplexing to the beginner of the natural tribes, are arranged with a degree of division and subdivision that cannot fail to puzzle the novice who has not a natural turn for the minutiæ of arrangement.

This intricacy of division is more remarkable in the Cryptogamic Orders, where indeed it is more necessary. But could it not be so managed, that a few divisions, such as those recommended and used by Linnæus, might be made sufficient to preserve the generic characters in their proper places, and, instead of puzzling the student, serve as a clue to guide him directly to the genus for which he was searching*? And is it not to be apprehended that a too frequent division abstracts from the naturality of the essential character?

The division of species ought in particular to be perspicuous, and, if possible, not to be subdivided, simplicity or unity being the essence of perspicuity. And it cannot but be regretted that the Hypnums, Bryums, Jungermanniæ, Lecanoræ, and others, cannot be reduced to the regular method followed with less intricate genera. A want of uniformity is thus produced, which in an artificial system ought to be studiously avoided. But this want of uniformity is displayed also where there is less excuse for it than in the genera mentioned. The genus Rosa, of which there are only ten species described, has half as many divisions as species, and each division dignified with a name in capitals and a long character in Italics, as if it really constituted a natural order. A method of this kind may do well enough in a Monograph, but in a Flora regularity and consistency should be preserved: and whatever merit Mr Woods and Mr Lindley may have for their prolix descriptions of Roses, Dr Hooker can have little for adopting their method, when it stares the other genera of his arrangement out of countenance, by its disproportioned figure.

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* Synopsis est dichotomia arbitraria, quæ instar viæ ad Botanicem ducit, Limites autem non determinat.—*Phil. Bot.*

Clavis Classium synoptica est ex artis lege, ne confundantur, distinguenda.—*Phil. Bot.*

The construction of the Generic Characters is, in the next place, to be considered. The necessity of certainty, conciseness, and perspicuity, in this department, must be too obvious to all to require elucidation. And in reference to those points, the generic tables of the Flora Scotica merit in general the greatest praise. There are, however, exceptions. The essential character, taken in the strictest sense, made up not so much with a reference to artificial system or to synoptic conveniency, as to distinctive natural characterization, is certainly the best when attainable. But cases exist where it cannot be obtained in this purity, and where recourse must be had to a more prolix, but perhaps equally certain method. Allusion is here made to the practice, in extensive natural orders which happen to coincide with the artificial arrangement, of selecting certain points of contrast. In Didynamia, for example, the calyx and upper lip of the corolla; in the Grasses, the calyx, corolla, and seed, are taken for points of contrast. Now, in such a case, would it not be better to preserve a certain regularity without deviating from it, unless in the case of a single natural character taken from a very remarkable peculiarity in form, and to construct those partly factitious characters with an uniformity that might lead the student at the first glance to detect the genus of his plant? The synoptical Generic Table of the Grasses displays this want of uniformity, which ought in every case to be avoided, and which in this particular one is a source of confusion. Objection must also be made to the manner in which the seed or fruit is used in the Grasses. In some it is not mentioned at all, in others it is mentioned where it can be of little use. In truth, however, the characters taken from the seed are of little importance, there being nothing in the circumstance of its being fixed or free, to constitute more than a divisional character. Pentandria Digynia, consisting of the Umbelliferæ; labours under similar objections: but the fault in both cases is more dependent upon the difficult nature of those orders, than on Dr Hooker's arrangement. However, this in no degree takes from the truth of the assertion, that where points of contrast have been chosen, they should be strictly adhered to, and exhibited with clearness.

In regard to Specific Characters, the same remark acquires the same force: and here a deviation from order is more blameable, as there are generally fewer causes of distraction, and the characters are more readily comprehended by one sweep of the eye. In the species of Poa, for instance, there is not sufficient adherence to regularity. The characters here might be taken from the panicle, spikelets, florets, culm, and root, unless a more compendious method should be devised:—and let it not be imagined that specific characters are the more correct that they are verbose, and taken from many circumstances. Linnæus confined himself to a few, and made his characters concise; and though instances occur in which a greater profusion of words is necessary than he was in the habit of using, it should be remembered that the strength of a character is in general proportioned to its concentration. The idea of limiting the number of words to twelve may be ridiculed, but the sense of propriety which led to it must not be censured; and as Smith justly observes, his remark, that "Genuine specific distinctions constitute the perfection of natural science, is strongly confirmed by the great inferiority of most botanists, in this department, to that great man, and especially by the tedious feebleness and insufficiency displayed among those who court celebrity by despising his principles." Let us compare the characters of the species of *Hieracium*, for example, in the Flora Scotica, some of which have from thirty to fifty words, with the characters commonly given by Linnæus; and we will be convinced that the latter are preferable, and that the former, though assuming the form rather of descriptions than of essential characters, are deficient in point of strength and perspicuity

In examining the Flora of a country, one of the most important criteria exists in the completion or defection of the number of species. In this respect, very few individuals indeed can judge with accuracy; and, probably in this particular case, none who have not subjected themselves to the same labour, and enjoyed the same advantages as our author. But that there are deficiencies, could easily be shewn. The following may serve as a specimen: *Sonchus palustris*,—on Don Braes, near Aberdeen; *Vicia bithynica*,—not uncommon about Aberdeen; *Epilobium roseum*,—in the outer Hebrides.

The common *Grey Oat* of the North Highlands and Hebrides has an equal right to be admitted with *Avena fatua*, or *Agrostemma Githago*, occurring in corn fields in various parts of Scotland.

The low, robust Alpine Juniper, so common in the Hebrides and West Highlands, where the common kind is not seen, is worthy of particular notice, if not as a species, at least as a variety:—

A pentandrous *Cerastium*, very different from *C. semidecandrum*, but growing along with it and *C. tetrandrum*, in various parts of Scotland, along the coast:—

Nuphar ———, differing so much from *N. lutea*, as to be at least a variety, if not a distinct species, and approaching in character to *N. minima*, but much larger, plentiful in the Corby Loch, Aberdeenshire, and not seen elsewhere.

The redundancy of species is, in the next place, to be pointed out, or the admission of plants not truly indigenous. Perhaps, in regard to this subject, it would be proper in Floras to divide the plants into those indisputably indigenous; those introduced by accident or design, and naturalised; and these exotics which have gained but a very slender footing, not sufficient to admit them into the second class. Examples of the second class are, *Tanacetum vulgare*, *Scandix odorata*, *Avena fatua*, *Imperatoria Ostruthium*, *Chelidonium majus*. Of the third kind, those which are most objectionable in the Flora Scotica, appear to be the following: *Phalaris canariensis*, *Medicago falcata*, *Cochlearia Armoracia*, *Brassica Rapa*, *Cornus sanguinea*, *Anthemis nobilis*, *Inula Helenium*, *Carum Carui*, *Ribes rubrum*, *R. nigrum*. *R. Grossularia*, *Vinca minor*, *Polemonium cœruleum*, *Ornithogalum umbellatum*, *Asarum Europæum*.

In a Flora intended for common use, it is perhaps quite enough to select, by way of description, those peculiarities which are eminently distinctive. Yet, in a more perfect work, it might be advisable to give the description of the species at full length; because peculiarities of climate, soil, and situation, not unfrequently cause very remarkable deviations in the habit and form of plants, or of particular portions of them; and any one who has compared the excellent descriptions of Smith, with real specimens of the plants of Scotland, must have found that points of discrepancy occur, not indeed essential, but such as might perplex the student, and prove interesting to the adept. Dr Hooker's descriptions, which are of the first or compendious kind, are generally excellent, yet not invariably so. In plants which are not liable to be mistaken, such as *Alchemilla vulgaris*, *Butomus umbellatus*, *Monotropa Hypopitys*, *Zostera marina*, *Arum maculatum*, *Adoxa moschatellina*, the descriptions are sometimes longer than those allotted to such as the Grasses, Epilobia, Gerania, Carices, Salices, which are peculiarly difficult to the beginner. It is, however, to be kept in mind, that minute descriptions, deviating from the common plan, are necessary on occasions; as when the plant has been confounded with others, or when a species has been improperly divided into several, or when there is some remarkable peculiarity in structure, or when the plant is exceedingly rare, or in genera difficult from their number of species. Thus in *Agrostis alba*, *Tussilago petasites*, *Parnassia palustris*, *Linnæa borealis*, *Carex* and *Salix*.

Remarks might now be made upon the numerous changes effected of late years among genera; but this department could not be treated with sufficient brevity, the discussion involving subjects of primary importance in botanical criticism. On surveying the changes, however, which are daily taking place, one cannot but think, while he admits the propriety of many, that authors are rather too unsparing of the power which they assume; and that botany is verging to a period when another Linnæus may be wanted to give a new consolidation and beauty to its *rudis indigestaque moles*.

It now remains to consider the manner in which the vernacular Names, Habitats, Localities, general remarks regarding Soil, Situation, or Altitude, time of Flowering, and observations regarding the Uses, economical or medicinal, to which plants have been or might be applied by the natives, have been treated; for such are essentially necessary in the construction of a Flora, and, although not mentioned in the title-page, have been more or less noticed through the work.

In looking over the volume, a Scotchman, whether Highlander or Lowlander, might be somewhat surprised to find none of the names which he has been accustomed to hear among the natives. We have indeed adopted the English language, but the mass of the people still retain their original dialects; and in a Flora of our country we might expect to be humoured a little in this particular. Our Blacwort, Gueel, Rot-girss, Rantree, Arn, Sourock, and other names, together with Neoncin, Slanlus, Achlasan-Challum-cille, Seamrag, &c., are not less expressive, nor less worthy of a place in a Scottish Flora, than their English synonyms. Some of the English names also are objectionable, as being, instead of vernacular, mere echoes of the Latin systematic names; for example, *Tuberous Orobus*, instead of the legitimate name Heath-pea. And the whole Cryptogamic legion is without vernacular names, English, Scottish, or Gaelic, excepting a very few that have been assigned a place among the notes.

The *habitats*, it is believed, are correct, in as far as the plan used might admit. Every country has its own peculiarities, and reference ought to be made to them. In Scotland we have nearly the same varieties as those described by Linnæus, in his Philosophia Botanica. We have corn-fields, fields, cultivated places, gardens; pastures dry and wet, meadows, marshes, ditches, ponds, lakes, rivers, rivulets, springs, wells, mountains, hills, with alpine situations and valleys, ravines, rocks, maritime cliffs, sands on the sea-shore, heaths, moors, woods of fir, birch, hazel, with many other varieties of situation. Then for soil we have sand, both quartzose and shelly, or calcareous, peat in abundance, gravel, clay, marl, black soil, and their compounds. For subsoil we have granite, and gneiss of numerous varieties, porphyry, amygdaloid, sandstone, quartz, compact felspar, mica-slate, clayslate, claystone, puddingstone, greenstone, basalt, and many others less general. To have some regard to those in marking habitats would be absolutely necessary. Nor is it the case that every plant grows in a similar situation in all countries. Hence error might arise. In marking the elevations of plants, the philosophical botanist might derive much useful information from comparing the altitudes in various latitudes. But the Flora of any country requires an account of its geographical limits, of its surface and soil, climate, and other particulars, prefatory to the list or description, which would preclude repetitions and verbosities in the accurate describer. The days are gone by, when a mere list of plants was satisfactory to the botanist, and we now require something more philosophical. It might be mentioned also, that the nudity of the science has rendered it less useful than it might be made, and has prevented many from bestowing a portion of their time upon its cultivation. What should we think of medical science, were it merely an arrangement and description of diseases, such as we see in systems of nosology, with a few brief and unsatisfactory notices regarding the variety produced by temperament, idiosyncracy, climate, and season of the year? Yet what has botany been, but the parallel of this?

The frequency of occurrence should always be noticed; and when the plant is rare, it has been the custom to mention *localities*, which brings us to that subject The localities of the Flora Scotica of Dr Hooker, must certainly have cost the author much trouble in collecting them; yet they are less numerous than we anticipated. The deficiencies in this respect come under three heads. 1*st*, When plants rather common are mentioned as rare. 2*d*, When too few localities of very rare plants are given. And here it is necessary to remark, that a country, previously to describing its vegetables, should be divided into districts; a practice fraught with many advantages. And this leads to a *third* division, namely, of plants common in certain districts, but rare or wanting in others. Of the first kind, it does not appear that there are many examples in the work, that might not be referred to the third. Belonging to the second division are numerous species, of which any botanist who has travelled extensively in Scotland could particularize localities not mentioned. For example: *Linnæa borealis*, Fir-wood opposite Fintray, Aberdeenshire, two large patches; fir-wood in Midmar, Aberdeenshire. *Lithospermum maritimum*, Bay of Nigg, near Aberdeen; Vatersey, one of the Isles of Barrey; Island of Skye, at Kyle-rhea, and other places. *Cicuta virosa*, Islands of Pabbey, Bernerey and Ensey, of the Herries; Ord, in the island of Skye; near the head of Lochfyne, opposite Carridu, Argyleshire; near Gatehouse, Kirkcudbrightshire; near Kildrummy Castle, Aberdeenshire; at Leuchars, near Elgin, Morayshire, &c. *Botrychium Lunaria*, at Arisaig, Inverness-shire; in the Outer Hebrides plentiful; in Towie, Aberdeenshire; abundant in many places along the coast from Aberdeen to Newburgh. To enumerate more examples of this kind, would be a tedious task; only it may be mentioned, that the *Hordeum murinum*, contrary to the suspicion of Mr Arnott, grows north of the Forth, namely, near Elgin; while *Orobanche rubra* is not confined to basaltic districts, as imagined, but grows among the gneiss of the Herries, perched upon a rock at the head of the sand of Bencapval. Of the third class, *Circæa alpina*, is common in the middle Highland districts; *Utricularia intermedia*, in the outer range of Hebrides; *Sesleria cærulea*, every where in the West and North Highlands and Hebrides; *Anagallis arvensis*, chiefly along the west coast; *Conium maculatum*, not found in the Outer and Northern Hebrides; *Nymphæa alba*, very common in the pools and lakes of the Hebrides; *Lobelia Dortmanna*, in almost every lake of Scotland, but particularly abundant in the Outer Hebrides; *Serratula alpina*, in the valleys of the Highlands, from Braemar to the west coast, and from Lochlomond to Lochbroom. But to enumerate the whole of this kind, mentioning their distribution even in a general manner as above, is not consistent with our present view.

Remarks regarding *soil*, *situation*, and *altitude*, are but thinly interspersed through the Flora Scotica. How interesting the latter subject might have been made, let those consider, who have read the extract from Dr Wahlenberg's "Observations, made with a view to determine the height of the Lapland Alps," appended to the Lachesis Lapponica of Linnæus, edited by Smith. Soil, in general, is not a subject of primary importance, as a very great proportion of plants grow nearly equally well in almost all soils. There are, however, striking exceptions. Situation is of greater importance; and with due attention to it, the Flora of Scotland might have been exhibited in a very interesting form. In as far as the plan of the Flora Scotica admits, the notices relative to those are correct and interesting.

The time of *flowering* is another subject of importance; and where no general observations have been made upon it as influenced by situation, difference in latitude, prevailing winds or rains, or other circumstances, great precision cannot be expected. There is in our country a very great difference in different districts. The *Draba verna*, for instance, flowers at Edinburgh sometimes in January, at Aberdeen about the middle of February, in the Herries not till the middle of April. The *Ranunculus Ficaria* flowers on the east coast of the middle division of Scotland about the 10th of February, on the west coast of the northern division about the beginning of April, in the more northern of the Outer Hebrides about the beginning of May. It might be better also to note the time of a plant's first flowering, when it is in general bloom, and when it is generally fading.

Remarks on the economical and medicinal uses made of plants by the natives, we regret are not so numerous as could have been wished; but as it is a favourite subject with us, we would presume to give the following as a specimen of the mode in which these uses might be detailed.

ARUNDO *arenaria*. This plant, which is generally known in Scotland by the name of *Bent*, in Gaelic *Muran*, is common on the coast wherever there is loose sand, which it serves to consolidate by its long tough roots. At Aberdeen it is manufactured into door-mats, called Basses. It also makes excellent floor-brushes. In the Outer Hebrides, where it is plentiful, it serves many purposes in rural and domestic economy, being made into ropes for various uses, mats for pack-saddles, bags, mats, and vessels for preparing and keeping grain and meal; and, lastly, into hats. When made into meal vessels, it is bound together by its own slender and tough roots; but this should be prevented, as the digging for them loosens the sand. In Holland it is planted for the purpose of binding the sand, and this practice has been introduced among us by Mr Macleod of the Herries, who has tried it extensively upon his estate.

RANUNCULUS *Flammula*. A very powerful epispastic, and known as such to the Hebridians, among whom it is in common use, under the name of *Lus-mor*. Applied in the form of cataplasm, the stalks and leaves being chopped small, and rubbed between two hot stones, it produces a blister in about an hour and a half. But its operation is rather violent, and on this account Cantharides are preferable, unless in cases where it is of importance to procure a blister in the most expeditious manner.

R. sceleratus. Is also a very powerful epispastic, being rather more violent in its action than R. *f.* But the blistered surface is difficult to heal, passing into an irritable ulcer; and on this account the plant cannot be used with safety. Both species lose their acrimony by drying; hence in the form of powder they would be quite useless. They might, however, probably be preserved in the form of liniment or tincture.

Our few imperfect remarks upon the work of Dr Hooker are now concluded. If the Flora Scotica is not precisely such as all might have wished, it is yet what few botanists of our country could have accomplished; and while it will remain a monument of great talent and indefatigable industry, it will yet, by its deficiencies, leave room for some botanist of enterprise to bestow his labour on a production better adapted to the prevalence of an improved taste among naturalists, which leads them to consider the mere description of the plants of a country as scarcely sufficient to gratify curiosity. For something of this kind we may confidently look to our distinguished author; and botanists of less eminence will wait with anxiety the appearance of a work which cannot fail to add to the already splendid reputation of Dr Hooker.

These remarks on the Flora Scotica, it may be mentioned, are merely introductory to some views on the mode of constructing a Flora, which are intended as the subject of a future communication.

ART. XXVII.—*Account of the Thermal Springs of Yom-Mack.* By JOHN LIVINGSTONE, Esq. Surgeon to the British Factory, China. Communicated by the Author.

ABOUT two years ago, I was informed that some interesting hot-springs existed north-west of Macao, about fifteen miles distant, and at the same time specimens of the different wells were given to me, for the purpose of analysis, in order that I might be able to ascertain the probable virtues of the water as a medicine. The temperature had only been tried by the rude experiment of boiling eggs, which was perfectly accomplished in the space of two minutes.

A few days afterwards, two of the Portuguese clergymen of this city having been furnished with proper instruments, made an excursion to the hot-wells, a written account of which I was favoured with on the 20th April 1819. I also received other specimens of the water, carefully taken, on which the temperature of the wells which my friends examined, were marked with great care.

Although the result of the analyses of the water only proved that it was sea-water mixed with about an equal part of common water, yet a temperature extending from 130° to 190° Fahrenheit in the hottest spring, presented facilities for warm-bathing, which, together with the advantages of change of air, scene, and the journey, promised great benefit to the sick and convalescent. These circumstance induced Sir Theophilus Metcalfe, then the chief of the British Factory, and himself a convalescent from a protracted illness, to apply to the Chinese local magistrate for permission to have free access, both by land and water, for the benefit of himself and others. After some hesitation, this request was civilly refused, under pretext that the concurrence of the military commandant was necessary, and which his instructions would oblige him to refuse.

Having thus no prospect of visiting the hot-wells in a regular and comfortable way, I begged to accompany the gentlemen who gave me the account of them, when they went again to the springs. Circumstances which it would be foreign to this account to detail, prevented them from being able to gratify my wishes till yesterday, when I had the pleasure to examine these very interesting hot-springs, together with my friend Mr Reeves.

We left Macao before four o'clock in the morning of the 11th April 1821 for Yom-Mack, the name of the place where the hot-springs are situated, in East Long. 113° 28′; and North Lat. 22° 24′. This agrees with the Portuguese estimated distance in a direct line; but as our fast-rowing boat was five hours and a half, with a favourable tide, in reaching the spot, the distance must rather exceed than fall short of twenty miles.

I was happy to observe, that the account of my Portuguese friends, so far as it goes, is sufficiently exact. It will therefore serve to assist me in drawing up from my notes the following details.

From Casa Branca we proceeded across the alluvial flats which seem to have been gained from the sea very recently, and which are defended against its future encroachments by a very substantial stone embankment, consisting of the various species of granite, which are common here, with occasionally a small mixture of sienite. These embankments have been constructed within the last four years, when I had an opportunity of observing these flats.

Our guide informed us, that they seldom went through these embankments twice the same way. Our course was continually altering from about north to west, but most frequently about NW. by N. till we opened the Broadway *. We then entered the hot-springs river, having Tanchow on our right and Machow on our left. At this time Ta-hung-chow Island bore S. 50 W. and Paik-payak Rock S. 27 W. distance about four miles.

Our course up this river was from about N. by E. to NNE. At the entrance, it is about one-third of a mile broad. In two or three miles it contracts to about 250 yards, which breadth continued as far as we ascended it. We did not ascertain its depth, but, from the size of the boats which we observed to be employed on it, it must be considerable. The tide rises about three feet. At the hot-wells the water of the river is quite fresh, even at high-water.

This river has a very pleasing appearance. From both banks a flat alluvial soil extends two or three miles to the mountains, which appears to be well adapted to the cultivation of rice, and which, from the great number of farm-houses that we observed at very short distances, must be cultivated with considerable spirit. These farm-houses do not seem generally to be either commodious, or substantially built: they are commonly surrounded with a slender bamboo paling, and have at least one Melia Azedarach tree planted close on the south side, which were now in full flower, giving a pleasing effect to the landscape.

The banks of the river, for about a mile from its mouth, are covered on both sides with Arundo, Carex, and Juncus, the

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* The Broadway is called by the Chinese the Gulf of Sheuy-le.

species of which we had no opportunity of determining. Soon afterwards these began to be mixed with Crinum Asiaticum of a large size, Acanthus ilicifolius, also very large, Clerodendrum trichotomum, Pandanus odoratissimus, Euphorbia antiquorum? and soon gave place entirely to these plants, which continued in great profusion, with occasionally a few rushes, and patches of cotton grass, till we reached the springs.

These are situated within 100 yards of the right margin of the river, near a considerable rivulet. The land is quite flat, and about six feet above the level of the river at high-water. The soil is commonly alluvial clay, mixed near the springs with various proportions of carbonaceous matter and sand, which gives a considerable variety to the colour, that next the hottest springs being almost black, while round the more temperate it is only grey.

We had only three springs pointed out to us The first and largest appeared to be covered with a cloud of steam, and could be approached with facility, the ground being quite firm: it was in a state of most active ebullition; columns of steam, arising from a depth of ten feet, impressed on the mind a sublime effect. The estimated diameter of this well is thirty feet; and it discharges at least fifteen gallons of water a minute. We perceived no particular smell; and the plants already mentioned grew quite close to the margin of fully one-half of its circumference. Its temperature is 150° Fahr.; the Portuguese account makes it 160°, and the temperature of the ground throughout the neighbouring swamps 85°.

Within about thirty paces of the spring just mentioned, we examined another spring, the temperature of which we found to be 132° Fahr.

The third well is distant from the first sixty paces, as ascertained by the Portuguese clergyman, but the shrubs having interrupted their way since their last visit, we were obliged to make a circuit of not less than the third of a mile when we reached the smallest, but by far the most active spring, of an oblong shape, about two feet deep, and eight or nine feet round. The temperature of this Mr Reeves ascertained to be 186° Fahr., my Portuguese account makes it 190°. Its smallness no doubt subjects this well to considerable variation of temperature. Mr

Reeves's foot having sunk pretty deep into the swamp near this spring, he experienced a painful sensation of heat; I was therefore unwilling to follow him nearer than about ten yards.

The temperature of the ground here is too high for shrubs. Indeed, in some places the ground is quite bare, and, for the extent of a circle, whose radius may be estimated at 100 feet, we observed only patches of carex, juncus, and the like.

The space occupied by the hot-springs may be about a mile in circumference, forming a swamp, the north half of which is extremely bare of shrubs, but the remaining portion is covered with the shrubs before mentioned, from five to six feet high. The Croton sebiferum tree appeared in some places of the size of a shrub. There we observed no Crinums.

This spot is placed near the centre of a most beautiful amphitheatre, the circumference of which is from fifteen to eighteen miles. The outline is formed by a number of mountains, from 800 to 1300 feet high. These mountains rise with a slope of about 45°, which has the appearance of being broken by ridge lines into various compartments, of a triangular or nearly pyramidal form, so softened by a complete covering of verdure to the summit, that with the mild sunshine which the haze of the morning admitted, all the outlines appeared rounded in the most pleasing manner. The effect was exceedingly delightful, every object seemed, in the language of the painters, in complete repose.

No rock or other mineral production could be perceived, excepting one large block which (from being familiar with such masses,) I judge to be of granite, intersected at nearly right angles with lines of quartz, situated from 500 to 600 feet up a mountain, bearing SE. distance three miles.

From a general similarity in the appearance of these mountains to some we have had an opportunity of examining, and also from the same sharp ridges appearing when passing them to the west, we have been induced to infer a similarity of structure, which may be shortly thus described. The high sharp ridges consist of vertical veins or walls of quartz, seldom exceeding a yard in thickness; while the rock thus intersected is granite, with a few appearances of stratification; but where these are observed, the inclination is highly vertical.

rarely so low as 45°. The mountains here, and I have been informed, in such parts of China as Europeans have visited, are covered to the tops with a hard crust of red earth, commonly called Tilt. This is often converted into terraces, on which most vegetable productions seem to thrive, and is that most proper for the cultivation of the tea-plant, but it screens from our view the structure of nearly all the mountains, which must long retard our acquaintance with the geology of China.

The amphitheatre which surrounds the hot-wells, may be imagined by some to be the remains of a volcanic crater on a large scale, which now retains scarcely sufficient heat to make water boil, but the want of every vestige of volcanic productions seems to be an insuperable objection to this supposition.

The electric hypothesis advanced by several naturalists, and which has been acutely illustrated by Mr P. Inglis, seems to afford an interesting explanation of our thermal springs. Such stratification as his theory requires, may doubtless exist here; and the sea-water may serve to excite an immense natural galvanic pile, one of the poles of which may terminate where the hot-springs of Yom-Mack have their origin.

MACAO,
12*th April* 1821.

ART. XXVIII.—*Remarks on the Specific Gravity of Sea-Water in different Latitudes, and on the Temperature of the Ocean at different Depths* *. By Dr J. C. HORNER.

THE observations on the specific gravity of the sea-water have been already drawn up in an instructive table by the

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[*] Having already laid before our readers the Observations on the Specific Gravity of the Sea-Water, and on the Temperature of the Sea made during the three late Expeditions to the Arctic Regions, under Captain Ross, Captain Buchan, and Captain Parry, and also the observations of Captain Scoresby, Mr Livingstone, Dr Marcet, and Dr Traill on the same subject, we are now enabled to extend the series by those which have been made during Kotzebue's Voyage of Discovery. M. Horner, the author of the "Remarks," was, we believe, Astronomer to the Russian Voyage of

able naturalist of the expedition, and arranged according to the degrees of latitude. This table evidently shows the fact, which is also proved by the experiments on Krusenstern's voyage, that the sea on the surface, between the tropics, is specifically heavier, and that it contains more salt, than in higher latitudes. If we take together the statements from 25th degree south, as far as 25th degree north latitude; and, in the same manner, from 50° to 65° degree of north latitude, the mean of the first is 1.0288, that of the latter 1.0245, which gives the difference of 0.0043 or $\frac{1}{240}$. But this by no means proves an absolute inequality in the saltness of the water in general. To give a decided opinion on it, the sea-water must be fetched up from considerable depths, and weighed. Probably the greater saltness arises from the rapid decrease of the fresh water, in consequence of evaporation. From the well known slowness of the transition of chemical elements in undisturbed compounds, this decrease is but slowly repaired; and as the upper layers are also the warmer, they may, notwithstanding their greater specific density, in consequence of their extent, be maintained by the warm swimming above the lower cooler layers, by which a principal agent of commixture, the difference of weight, is rendered of no effect. This slowness of change, and the condensation of the saline solution at the surface, which results from it, has the advantage, that the acceleration of the evaporation sets bounds to itself, because, with the increasing condensation, the attraction of the salt to the parts of the water is greater, and, consequently, the diminution of the latter less. Without this arrangement, the tropical seas would perhaps be covered like the frozen seas of the north, with constant fogs. Subsequent experiments will show how far our explanation of this inequality is correct; of which we have now more hopes, as convenient accurate apparatus have been discovered to fetch up water from any depth, at pleasure, and unmixed.

The considerable number of observations (there are one hundred and sixteen of them) on the temperature of the sea below

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Discovery under Baron Krusenstern. See this Journal, Vol. II. p. 356. Vol. III. p. 247., Vol. IV. p. 185.—268, Vol. V. p 206, 220.; and Kotzebue's *Voyage*, Vol. III. p. 425.—Ed.

the surface, their extent over waters of the ocean remote from each other, and probably, also, their accuracy, give them a decided claim to the attention of the natural philosopher; and the perseverance with which they were continued, under various circumstances, does honour as well to the Naturalist of the Expedition, as to the commander, who not only in calms, but in some periods, almost daily, afforded the necessary assistance. They were all made with Six's Thermometer, which is a good assurance of their accuracy. It is certainly remarkable, that an instrument so simple, so convenient in the use, so certain in the results, and which has been long known, is not more frequently used for this purpose; so that in the latest scientific voyages, much more uncertain thermometers have been used, to which only the deep sea clamm of Captain Ross forms an exception.

Our observations fall under two heads: measurements of the temperature in different depths, in the same places of the ocean, and in statements of the warmth in the usual soundings, from sixty to eighty fathoms, in different places.

The most complete observations on the changes of the temperature, in increasing depths, are, in the South Sea, of the 13th and 14th of September 1817, in 36° north latitude, and 148° west longitude. Besides confirming the general law, that the cold increases with the depth, they also afford the following results.

1. The upper parts of the water show a particular warmth, as the temperature, in the first eight fathoms, diminished only 0°,4 R., but from that depth to twenty-five fathoms, full 6° R. From twenty-five fathoms to a hundred fathoms' depth the decrease of warmth is considerably less, since, in the next twenty-five fathoms, it is only 1°,7 R., and in the next fifty fathoms, only 1°,5 R.; a decrease which amounts to only the tenth part of the preceding. It is still slower between a hundred and three hundred fathoms.

2. If we compare these observations with those of the 6th of June 1816, in 37° north, and in 199° west longitude, consequently, in the same parallel of latitude, the influence of the season is particularly observable in the temperature on the surface, which in June is 13° R., in September 18° R. It,

however, does not go much deeper than from twenty-five to fifty fathoms; and at an hundred fathoms it is already within the limits of the accuracy of such observations; for we have,

For 100 fathoms	6th June,	9,° 4	Reaumur
	13th September,	9, 4	—
	14th September,	8, 6	—

3. A certain coincidence with these results, only on a greater scale, is shown by the experiments of the 15th of November 1817, in 9° N. Lat., and 205° W. Long., in which the temperature decreases from the surface to about sixty or seventy fathoms, rapidly and uniformly, from 24°,7 R. to 8°,8 R. From 9 to 101 fathoms, this rapid decrease, instead of proceeding, is suddenly reduced to the small amount of 0°,9 R. But if we compare these observations with those immediately preceding and succeeding them, of the 13th, 14th, and 17th of November, we shall hesitate to draw from them decisive conclusions.

The observations of 13th April 1816, in 15° S., and 130 W , follow a quite different course from those in September 1817, in 36 N. The decrease of warmth from the surface, to as far as a hundred fathoms' depth, is much more inconsiderable, being here only 3°,6, there nearly treble, namely, 9°4, Reaum. It becomes more considerable between a hundred and two hundred fathoms, namely, 8°,8 R. Remarkable as this inequality is, it yet seems impossible to ascribe it to an error in the observation, such as too soon drawing up the thermometer; for, on the one hand, the regular course of the experiments of the 14th September 1817, and their coincidence with those of the 13th, at the depths of 0, 25, and 100 fathoms, does not allow us to suppose any thing of the kind; on the other side, the observations of 13th April 1816, find their confirmation in the preceding ones of the 7th April, in 18° S., which give a difference of 0 to 125 fathoms of 4°,8 R., that is, from 0 to 100 fathoms; likewise 3°,8 R. The same observations then give for the second hundred of the depth in fathoms, likewise about 8° Reaumur.

It is not to be discovered from the observations, whence this difference in the progressive decrease of the warmth arises. It cannot well be ascribed to the influence of the seasons, at least in Lat. 35° N.: the observations of June and September, show an agreement with each other. The reason perhaps is, that the perpendicular rays of the sun penetrate the water, between the tropics, to a greater depth than in latitudes where the sun never appears in the zenith. The place of constant temperature, independent of the seasons, must probably lie much deeper between the tropics than beyond them.

5. The observations of the 22d of September 1817, in 28° N. Lat. and in 152° W. Long. seem to present a much more uniform course, particularly if we set aside the statement in twenty-five fathoms' depth, which does not appear to agree with the higher or lower observations. We have from them a decrease of heat, of 3°.5 R. for the first fifty fathoms; 3°0. R. for the second fifty fathoms, and 4°.3 R. from a hundred to two hundred.

The collective observations on the progress of the decrease of heat were made in the South Sea. From the Atlantic Ocean we received only a few insulated statements, for depths of a hundred to two hundred fathoms. The experiments in both oceans are arranged in the following Table.

WARMTH of the SEA-WATER at different depths, arranged according to the Geographical Latitudes in degrees of Reaumur's Thermometer.

Month.	Surface.	70 to 90 Fathoms.	100 Fathoms.	200 Fathoms.	300 Fathoms	Latitude.	Longitude.	
April	21.0	—	17.2	9.9	—	18 S.	125 W.	
—	21.4	—	17.8	10.8	—	15	134	
May	22.6	—	13.5	—	—	1 N.	177	
Nov.	24.5	—	10.7	—	—	9	204	In the South Sea.
—	23.0	14.1	—	—	—	12	210	
Dec.	22.1	12.8	—	—	—	16	240	
—	21.7	16.6	—	—	—	18	224	
Sept.	20.1	—	13.0	8.8	—	28	152	
June	18.7	—	13.5	—	9.4	29	199	
Sept.	18.0	—	9.3	7,0	5.4 (4.8)*	36	147	* In 400 Fathoms.
June	13.0	—	9.3	—	5.0	37	199	
Jan.	10.4	—	—	3.2	—	44 S.	57	
March	17.3	—	12.3	—	—	34	27	In the Atlantic. Ocean.
April	15.8	12.8	—	7.9	—	31	15	
Oct.	18.9	—	10.6	—	—	30 N.	15	
—	16.4	—	—	11.0	—	39	13	

The temperatures in the usual soundings from 70 to 80 fathoms, appear, on account of their considerable number, from which mean numbers may be deduced, the best calculated to supply fundamental data. Yet some singular results appear in them. Among these is the statement in the South Sea, that in 18° N. Lat. and 76 fathoms' depth, in December, the water was $2\frac{1}{2}$° R. warmer than in 11° N. Lat. and 70 fathoms depth, in November. Perhaps the local places of observation have had here some influence. The observation in 11° Lat. lies in the west of the Mariana islands, and in the north of the Philippines, consequently sheltered against the warmer currents from the south, by a kind of wall, and open only to the north, while, on the other hand, the place in 18° Lat. lies more in the open sea. The temperature, found at a depth of 90 fathoms, in the Chinese Sea, to the west of Luçon, is remarkably cold; perhaps in consequence of the north-east currents prevailing in December.

Almost daily observations on the temperature were made in the Atlantic Ocean, from the 20th of April to the 13th of June, 1818, mostly at a depth of 70 fathoms. In order to balance the possible errors of the observations which may arise from the difference in the time that the thermometer was under water, I have added several together, and noted the mean number. They are in the following Table. The figures in parentheses show the number of observations, the mean of which is given.

Observation.		Temperature of the Water		Depth in Fathoms.	Latitude.	Longitude.
		on the Surface.	below the Surface.			
April 20.—26.	(5)	18.6	13.0	57	17° 15′ S.	3° 20′ W.
—— 27.—30.	(4)	20.8	13.5	66	10 24	12 2
—— 30.—May 4.	(5)	22.1	11.8	67	5 12	17 5
May 3.—10.	(8)	22.7	11.4	74	0 43 N.	20 28
—— 10.—16.	(7)	22.6	11.4	75	4 51	24 38
—— 15.—19.	(5)	21.2	11.5	67	9 34	29 38
—— 20.—24.	(5)	20.3	16.1	71	19 30	35 7
—— 25.—30.	(6)	18.3	14.8	71	31 0	36 30
—— 31.—June 6.	(5)	15.1	12.3	68	40 30	29 40
June 7.—13.	(7)	13.2	9.6	77	48 9	17 15

This table shows a similar anomaly to that which we noticed in the South Sea. That is, the proportionately low temperature near equator from 5° S. to 10° N. Perhaps the greater heat between 20° and 30° of S. Lat. might be a remnant of the southern summer. But the considerable increase of temperature in the zone, between 15° and 30° N. Lat. is still more remarkable. For though, towards the end of May, the sun was near the zenith of those parts, yet this influence, which could be only commencing here, must have shown itself in the waters near the equator, which the sun had just traversed at the time of those observations (in April), which was by no means the case. The temperatures at the surface indicate indeed this influence of the sun, being the highest at the equator (22½° R.), while the southern half of the tropical seas had already assumed an autumnal temperature, since we observe here, in 17° S., the same warmth (18½° R.) as in 30° N.

ART. XXIX.—*Account of the Observations made at Liverpool on the Solar Eclipse of September 7. 1820.* By THOMAS STEWART TRAILL, M. D. F. R. S. E &c. &c. Communicated by the Author.

THE following instruments were placed in the garden of my house, for the purpose of observation :

A grand Herschel 7 feet reflecting telescope.

A Ramsden achromatic telescope.

A small reflecting telescope by D. Adams, 1½ feet.

A new barometer by Bate, with adjustments for level, and rack-work nonius, &c. It was hung in a sheltered place, fronting the north, so that its thermometer gave the indications of the temperature in the shade; but the wind was not sweeping it very freely.

A Leslie's photometer.

Rutherford's register thermometer for both extremes.

Another register for lowest depression, hung fronting west, but screened. It was always 1° or 1½° higher than that attached to the barometer, and was not noted, being only compared occasionally.

Two other thermometers by Ramsden and Lovi, all of which agreed on previous trial.

Just as observations were beginning, the sky, which had been hitherto bright, became cloudy, and just as the eclipse began, the sun was wholly hidden in clouds, and did not again become visible, except for a few minutes after the greatest obscurity.

Note of Observations made during the Eclipse of Sept. 7. 1820.

Hour.	Barom.	Therm. attached to Bar.	Therm. in Sun.	Photometer.	General Remarks.
h ′ ″	Inches.			°	
11 30	30.13	65°	77½°	78	Sky tolerably clear.
12 0	30.13	65	69½	16	Sky overcast with thick clouds.
12 15	30.13	63¾	67½	19	Sky with some openings in it.
12 24 35			67	39	Do.
12 35	30.14	64½	71	52	Sun imperfectly visible, but disk obscure.
12 43	30.14	64¾	70	16	A few drops of rain. [place of S. invis.
1 0	30.13		65	12	Sky lowering, uniformly obscure; drizzling rain;
1 8	30.12	6[illegible]	65	9	Sky darker; threatens rain; remove telescopes.
1 24	30.13	62¾	60	9	Driz. rain almost ceased; gust of wind; S. invis.
1 35	30.13	61	60	5	Black sky; wind caused exposed therm. to sink
1 43	30.13	60¾	60¼	5	Darkness about this time greatest. [much.
1 45	30.13	60¾	60	3	This seemed the moment of greatest darkness.
1 55	30.13	60¾	61	4	Both thermometers nearly equal; sky lowering.
2 5	30.13	61	62	8	Body of sun partially eclipsed; visible about 1′
2 15	30.14	61	62	8	[or 2′, pale.
2 25	30.14	61¼	62¼	9	
2 29	30.14	61¼	62½	12	
2 35	30.13	61½	63	14	Clouds a little broken, but sun invisible.
2 45	30.13	62	64	20	
2 50	30.13	62	64	12	Heavy clouds again closed all round.
2 55	30 13	62	64	10	
3 7	30.13	62	63¾	9	Calculated end of the eclipse.
3 15	30.14	62	63¾	12	Sky as dense as any time of eclipse; more light
3 30	30.14	62¼	64	10	No rain, but uniformly cloudy.
3 45	30.14	62¼	64	10	All the instruments removed except Photom.
4 35				45	In a clear gleam of sunshine.

The rain was only a few drops: it began about 12^h 45′, and continued till about 1^h 24′. The rain was wholly over before 1^h 35′. It is singular that the thermometer attached to the barometer, in two instances stood higher than that exposed which hung on a wall fronting the south. This must have been owing to currents or gusts of wind, to which the latter was much more exposed than the former, which was sheltered by the foliage of trees. The minimum of temperature during the whole time by the register thermometer, was exactly 60°; and this was exactly at the time of greatest obscuration.

The wind was SW. through the day, a gentle breeze, until about one o'clock, when it blew in gusts, but soon subsided; and about four or five o'clock it was nearly calm.

In the Table, the time was taken by my watch, which was afterwards found by Mr Roskell to be 51″ slower than the true time at Liverpool.

LIVERPOOL,
November 1821.

ART. XXX.—*Observations on the Variation and Dip of the Needle, made during* KOTZEBUE'S *Voyage of Discovery.*

HAVING already laid before our readers the magnetical observations which have been made during the recent expeditions to the Arctic Regions, we have been at some pains to collect, from the Account of Kotzebue's Voyage of Discovery, the various observations on the variation and dip of the needle which are scattered through that work.

Although the Rurick navigated that part of the South Pacific Ocean where the variation curves are returning lines, which have a sort of pear-shape, yet Captain Kotzebue's observations do not commence till he had passed through the most interesting group of these curves. It is to be regretted, too, that his observations ceased, when he was navigating that portion of the Indian Sea, where he must have crossed no less than *three times* the line of no variation, which suffers such singular inflexions in that part of the world.

In the following Table of observations, we have added in the last column the declination of the needle, as given in Hansteen's variation chart, which we have published in a preceding volume. The agreement between these measures and those of Kotzebue, is very remarkable.

OBSERVATIONS *on the Variation of the Needle, made during Kotzebue's Voyage of Discovery.*

Longitude.	Latitude.	Variation.	Variation from Hansteen's Chart.
138° 47′ West.	14° 15′ 11″ South.	5° 0′ East.	
144 28½	14 57 20	5 36 E.	
146 46	15 20	6 16 E.	6
148 41	15 0	5 37 E.	6½
157 34 32″	9 1 35	8 28 E.	7
175 27 55	Equator,	8 4 E.	10
190 9 23	11 11 20 North.	11 18 E.	11
163 41	66 16 39	27 0 E.	27
	65 43 11	23 0 E.	24
171 12 30	65 39 33	24 45 E.	24
122 12 30	37 48 33	16 5 E.	13
157 52	21 17 57	10 57 E.	9
190 6 50	9 32 36	11 0 E.	11
189 43 45	9 28 9	11 38½ E.	11
189 7 59	8 54 21	11 30 E.	11
188 50 25	8 43 10	10 50 E.	11
188 52 7		11 11 E.	11
188 48	8 18 42	11 58½ E.	11
190 0 40	10 17 25	11 15 30 E.	11
166 31 53	53 52 25	19 24 E.	19
169 39 21	16 45 36	9 47 E.	9½
215 9 54	13 26 41	5 34 E.	

The following are the only observations on the dip of the needle that are given by Captain Kotzebue.

Longitude.	Latitude.	Observed Dip.	Dip as existing in Hansteen's Chart *.
122° 12′ 30″ W.	37° 48′ 33″	62° 46′	60°
157 52	21 7 57	43 39	32
190 6 50	9 32 36	17 55	4
166 31 53 W.	53 52 25	68 45	67

We have added the dip from Hansteen's chart, for 1780.

ART. XXXI.—*Proceedings of the Royal Society of Edinburgh.*

Nov. 5. 1821.—THE Royal Society resumed its sittings for the ensuing session.

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* See this *Journal*, Vol. IV, p. 363.

Professor Wallace read a description of a new instrument, which he calls an *Eidograph*, for copying drawings, either on an enlarged or a reduced scale. The instrument itself was exhibited to the Society.

A letter from Captain Boswell, R. N. to James Russell, Esq. was read, giving an account of Cleopatra's Needle, and of the method by which he proposed to remove it to England.

Nov. 19.—A paper by Robert Stevenson, Esq. civil engineer, was read, entitled, "*Observations on In and Off shore Tides.*"

At the same meeting, a notice by Dr Brewster was read, "*On Vision through Coloured Glasses, and on their application to Telescopes and Microscopes of great Magnitude.*" This paper is published in the present Number, p. 102.

Nov. 26.—At a general meeting of the Society, the following gentlemen were elected Office-bearers and Counsellors for the ensuing session.

Sir Walter Scott, Baronet, President.

Right Honourable Lord Gray,
Hon. Lord Glenlee, } Vice-Presidents.

Dr Brewster, General Secretary.

Thomas Allan, Esq. Treasurer.

James Skene, Esq. Curator of the Museum.

PHYSICAL CLASS.

Sir G. S. Mackenzie, Bart. President. Alexander Irving, Esq. Secretary.

Counsellors from the Physical Class.

Professor Russell.
Dr Hope.
Professor Wallace.
Henry Jardine, Esq.
Sir James Hall, Bart.
Dr Kennedy.

LITERARY CLASS.

Henry Mackenzie, Esq. President. Sir William Hamilton, Bart. Secretary.

Counsellors from the Literary Class.

Sir John Hay, Bart.
Rev. Dr D. Ritchie.
Right Hon. Lord Chief-Baron.
Reverend Mr Alison.
Thomas Thomson, Esq.
George Forbes, Esq.

Dec. 3.—Dr Kennedy laid before the Society a letter from Colonel Wilkes, with some preliminary observations on the method employed by the natives of India in quarrying, transporting, and raising a granite obelisk, about seventy feet high, which was erected at Seringapatam by Purneah Dewan, to the memory of Josiah Webbe, Esq. who died in 1805.

At the same meeting, a paper by Dr Brewster was read, " *On the Distribution of Silex in the Equisetum hiemale, and other Siliceous Grasses.*"

Dec. 17.—Dr Macdonald read a paper " *On some Peculiarities of Vision.*"

Art. XXXII.—*Proceedings of the Wernerian Natural History Society.* (Continued from Vol. IV. p. 427.)

1821, *March* 10.—At this meeting, Mr W. C. Trevelyan read a geognostic account of the rocks in the neighbourhood of Bamborough Castle, illustrating his description by a plan and specimens. Dr Robert Knox communicated to the Society some particulars relative to a Caffre albino lately seen by him at the Cape of Good Hope: and Mr John Deuchar, lecturer on Chemistry, gave an account of three very large loadstones, brought from Moscow. Mr Deuchar's account of these remarkable loadstones has already appeared in this Journal, Vol. IV. p. 426.

March 24.—The Secretary read a communication from Mr Edmonstone of Unst in Shetland, describing a new species of gull found there; and at the same time a specimen of the bird was exhibited. The Secretary likewise read to the Society remarks by Mr Burke of Calcutta on a Tartar book, some time ago presented by the Marquis of Hastings to the College Museum.

Professor Jameson then communicated to the Society a geognostic survey of the country around Inverness, and of the Great Glen of Scotland, made by Mr George Anderson of Inverness, illustrating the description by reference to a large plan of the district, and to specimens of the rocks and minerals. At the same meeting, Professor Jameson exhibited a very fine stuffed specimen of the Tapir of Malacca, and made some remarks on the habits of the animal, and its analogy to the Tapir of America.

April 7.—The Society met; but the funeral of Dr Gregory having been fixed for this day, an immediate adjournment took place.

April 14.—The Secretary communicated the result of a series of meteorological observations made at Clunie, Perthshire, by the Reverend Dr Macritchie. Also the description of a very large fossil reed, or tree, which occurred in the sandstone on the coast of Northumberland, illustrated by an etching, by Mr W. C. Trevelyan; and a notice regarding the extent of the plantations of the Duke of Athole in Perthshire, by Mr Graham.

Professor Jameson gave the Society an account of a map of the Interior of Africa, illustrative of the course of the Niger; constructed by Mr Macqueen of Glasgow.

Mr Stevenson, civil engineer, then read an account of the explosion of a high-pressure steam-boiler at Lochrin Distillery, near Edinburgh. This interesting communication has already been printed in this Journal, Vol. V. p. 147.

April 21.—The Secretary read a biographical account of the late William Wright, M. D. &c. communicated by the Doctor's relatives.

Professor Jameson read a communication from Dr Fleming of Flisk, describing the growth of a plant resembling a Trichia, in a solution of succinate of ammonia, illustrated by a drawing. This paper will be found in this Journal, Vol. V. p. 164.

Mr David Bridges afterwards gave an account of a new instrument for reducing drawings or writings, called the *Apograph*; invented by Mr Smith of Mauchline in Ayrshire; and Mr Smith being present, shewed the mode of using the instrument.

May 19.—Professor Jameson read a paper of Professor Agardh's, on the Metamorphoses of Algæ; and likewise communicated a series of meteorological observations made by Dr Knox at the Cape of Good Hope, which are published in this Journal, Vol. V. p. 279,—283.

Mr Falconar communicated a notice regarding the Tulipa oculus solis, a rare species of tulip sent by Lady Liston from Constantinople, and which had flowered in the garden at Carlowrie.

Mr Deuchar then read a paper explanatory of a cause for the occurrence of drops of water in the interior of regularly shaped crystals.

The meetings of the Society were adjourned till November.

ART. XXXIII.—SCIENTIFIC INTELLIGENCE.

I. NATURAL PHILOSOPHY.

ASTRONOMY.

1. *Burg's Observations on the Eclipse of the 7th Sept.* 1820. —Being desirous of seeing an annular eclipse of the sun, the Chevalier Burg went for this purpose to Klagenfurth in Carinthia. The cloudiness of the weather prevented him from seeing the beginning and end of the eclipse, and also the first interior contact; but he observed the evanescence of the ring to take place about $3^h\ 16'\ 57''.6$ of true time, or $3^h\ 14'\ 46''.4$ of mean time. The latitude of the place of observation he found to be $46°\ 37'\ 37''$; and the longitude, by various observations, was $47'\ 51''.2$ East of Paris. By trigonometrical operations, the longitude of the Cathedral of Klagenfurth was $47'\ 52''.8$; and its latitude $46°\ 37'\ 37''$. The distance of the place of observation west of the Cathedral was $0''.5$. By comparing the observations made at Klagenfurth with those at other places, M. Burg concludes that they cannot be made to agree, by adopting the diameters of the sun and moon, as given in Delambre's tables of the sun, and his own tables of the moon. He found, that the sum of the semidiameters must be diminished by $6''.2$, and their difference by $1''.6$; the semidiameter of the sun by $3''.9$, and that of the moon by $2'.3$. M. Burg had deduced an analogous result respecting the semidiameter of the moon, from observations of the immersion of stars of the first and second magnitude behind her limb; but as his researches respecting the moon's nodes did not require any such diminution in the semidiameters of the two luminaries, he is disposed to think that the above results may be owing to irradiation and inflexion.—*Astronomische Nachrichten*, No. I. p. 14.

2. *Astronomical Journal.*—The first number of a new astronomical journal, entitled, *Astronomische Nachrichten*, by that ingenious and active astronomer, M. Schumacher, Professor of Astronomy at Copenhagen, has just been published at Altona. Each number is to consist of a single quarto sheet, to be published whenever the Editor has received sufficient materials for it; and when any particular astronomical news is of an urgent na-

ture, a half sheet will be published, to avoid delay. Twenty-four numbers will make a volume, for which a title and index will be given. The articles in the first number are by Professor Posselt of Jena, Professor Nicolai of Manheim, Dr Olbers of Bremen, and the Chevalier Burg at Copenhagen.

3. *Astronomical Observations made at Bushey Heath, Stanmore.*—

Latitude 51° 57′ 11″3 North ; Longitude West in time, 1′ 20″ 93.

1821,		h	′	″	
Aug. 4.	Immersion of Jupiter's second satellite,	11	04	31	mean time at Bushey.
		11	05	25	mean time at Greenwich.
Aug. 11.	Immersion of Jupiter's second satellite,	13	42	25	mean time at Bushey.
		13	43	45	mean time at Greenwich.
Aug 11.	Occultation of λ Aquarius, Immers.	8	[illegible]	17.8	mean time at Bushey.
	Emers.	9	39	16	
Sept. 11.	Transit of Jupiter's first satellite,	10	23	29	mean time at Bushey.
		10	24	50	mean time at Greenwich.
Sept. 11.	Emersion of Jupiter's third satellite,	10	30	12	mean time at Bushey.
		10	31	33	mean time at Greenwich.

The immersion of λ Aquarius was instantaneous, and the time certain to a second. Dew having rendered the object-glass of the telescope somewhat obscure, the emersion was not so accurately determined. The appearance of the star, when in contact with the moon, renders the idea of a lunar atmosphere very improbable.

METEOROLOGY.

4. *Remarkable Aurora seen at Belleville, Inverness-shire, in a Thunder Storm.*—On the evening of the 23d August, about half-past nine o'clock P. M. when there was not a breath of wind, and when the thermometer stood at 63°, the noise of very distant thunder was heard towards the south. Sheets of very brilliant lightning illuminated the sky, issuing, in general, from a small black cloud near the horizon. I was surprised, however, to observe, that, with the exception of a few thin black clouds, which were rendered visible by the lightning, the greater part of the sky was covered with shining masses, like those which form the aurora borealis. The stars were easily seen through this luminous matter, which was arranged in irregular masses, separated by clear intervals, but having a tendency to assume the appearance of irradiations, diverging from the cloud whence the lightning appeared to issue. When the lightning flashed, it was propagated in a particular manner along these masses of light ; but

what was very singular, the luminous patches were constantly in a tremulous or undulating motion during the intervals of the flashes of lightning. They shifted their place, and changed their form, exactly like the light which appears in many of the varieties of the aurora borealis. As the luminous clouds now described, did not appear in the northern part of the horizon, and were distinctly related, in their position and form, to the thunder-cloud from which the lightning emanated, we are entitled to refer the two classes of phenomena to the peculiar electrical condition of the atmosphere. and to suppose that the phenomena of the aurora borealis may have an analogous origin.—D. B.

5. *Dr Wollaston the Inventor of the Æthrioscope.*—We have received from our ingenious correspondent, Mr Murray, the description of a new Æthrioscope of his own invention, which we intended to have printed in this Number. As the introductory part, however, contains repeated reference to Mr Leslie as the inventor of that instrument, we deem it necessary to make the following claim to that invention, in behalf of our distinguished countryman Dr Wollaston, as an apology, both to our readers and to Mr Murray, for questioning the accuracy of the historical part of his paper:

Before the publication of the late Dr Wells's ingenious work on Dew, which appeared in 1814, " *Dr Wollaston exposed a concave metallic mirror, turned upwards to the free air, with a thermometer placed in its focus, and proved the lowering of its temperature after a short time of its being thus exposed.*" At what time Dr Wollaston made this elegant experiment, we do not know, but he communicated it to M. Biot, who published an account of it in the *Bulletin des Sciences par la Société Philomathique, for November* 1816, in a paper entitled, *Sur la Deperdition de Calorique, qu' occasionne le Rayonnement des Corps vers les Ciel.* A short abstract of the above paper of M. Biot was published on the 1*st April* 1817, in Mr Brande's Journal, Vol. III. p. 184. and this abstract contains the above paragraph which we have quoted in Italics.

Mr Leslie's paper on the æthrioscope was read to the Royal Society of Edinburgh on the 16th March 1818, and he himself states *, that it was invented by him after *October* 1817. This paper contains no allusion whatever to the experiment of Dr Wollaston, which has been truly characterised as an elegant one both by M. Biot and Mr Brande. If Mr Murray, after examining the works referred to, shall consider his historical statement respecting the æthrioscope as correct, we shall willingly retain it, as it is not our business to decide for others.

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* Edinburgh Transactions, Vol. VIII. p. 484, 485.

OPTICS.

6. *Remarkable Dichroism of Tourmaline.*—A very interesting specimen of dichroitic tourmaline in the cabinet of Mr Allan, exhibits the most singular contrast of colours that I have yet found in any substance. The plate is cut perpendicular to the axis of double refraction, and also to the axis of the prism. In the direction of the axis the colour is a deep and brilliant blue, while in a direction at right angles to the axis, the colour is a very pale red approaching to pink.—D. B.

MAGNETISM.

7. *On the best kind of Steel and Form for a Compass-Needle.*—In the Bakerian Lecture "on the best kind of steel and form for a compass-needle," by Captain Kater, published in the *Phil. Trans.* 1821, Part I. the following results are given .—"1. That the best material for compass-needles is *clock-spring*; but care must be taken in forming the needle to expose it as seldom as possible to heat, otherwise its capability of receiving magnetism will be much diminished.—2. That the best form for a compass-needle is the *pierced rhombus*, in the proportion of about five inches in length to two inches in width, this form being susceptible of the greatest directive force.—3. That the best mode of tempering a compass-needle is, first to harden it at a red heat, and then to soften it from the middle to about an inch from each extremity, by exposing it to a heat sufficient to cause the blue colour which arises again to disappear.—4. That in the same plate of steel of the size of a few square inches only, portions are found varying considerably in their capability of receiving magnetism, though not apparently differing in any other respect. —5. That polishing the needle has no effect on its magnetism. —6. That the best mode of communicating magnetism to a needle, appears to be by placing it in the magnetic meridian, joining the opposite poles of a pair of bar magnets (the magnets

being in the same line), and laying the magnets so joined flat upon the needle with their poles upon its centre; then having elevated the distant extremities of the magnets, so that they may form an angle of about two or three degrees with the needle, they are to be drawn from the centre of the needle to the extremities, carefully preserving the same inclination, and having joined the poles of the magnets at a distance from the needle, the operation is to be repeated ten or twelve times on each surface.—7. That in needles from five to eight inches in length, their weights being equal, the directive forces are nearly as the lengths.—8. That the directive force does not depend upon extent of surface, but in needles of nearly the same length and form, is as the mass.—9. That the deviation of a compass-needle occasioned by the attraction of soft iron, depends, as Mr Barlow has advanced, on extent of surface, and is wholly independent of the mass, except a certain thickness of the iron, amounting to about two-tenths of an inch, which is requisite for the complete develepement of its attractive energy."

8. *Effects of Magnetism on Chronometers.*—In our two preceding Numbers, we have had occasion to direct the attention of our readers to the very interesting and valuable researches of Mr Barlow, respecting the effect of magnetism on chronometers. The following interesting anecdote relative to this subject, has been communicated to us by an esteemed correspondent: " When Harrison's timekeeper was under trial at Richmond, it did not go as was expected. No one suspected the cause, till his late Majesty George III., who interested himself much about the machine, suggested that it was affected by a magnet which was lying near it. The magnet was removed, and the timekeeper recovered its rate."

ELECTRO-MAGNETISM.

9. *New Electro-Magnetic Apparatus.*—Mr Faraday of the Royal Institution, has recently constructed a new apparatus for the revolutions of the wire round the pole, and a pole round the wire. " When Hare's calorimotor was used to connect with it, the wire revolved so rapidly round the pole, that the eye could scarcely follow the motion, and a single galvanic trough, containing ten pair of plates on Dr Wollaston's construction, had power

enough to move the wire and the pole with considerable rapidity. It consists of a stand, about three inches by six, from one end of which a brass pillar rises about six inches high, and is then continued horizontally by a copper-rod over the stand; at the other end of the stand a copper-plate is fixed with a wire for communication, brought out to one side; in the middle is a similar plate and wire; these are both fixed. A small shallow glass cup, supported on a hollow foot of glass, has a plate of metal cemented to the bottom, so as to close the aperture, and form a connexion with the plate on the stand; the hollow foot is a socket, into which a small cylindrical bar-magnet can be placed, so that the upper pole shall be a little above the edge of the glass; mercury is then poured in until the glass is nearly full; a rod of metal descends from the horizontal arm perpendicularly over this cup; a little cavity is hollowed at the end and amalgamated, and a piece of stiff copper-wire is also amalgamated, and placed in it being attached by a piece of thread in the manner of a ligament, passing from the end of the wire to the inner surface of the cup; the lower end of the wire is amalgamated, and furnished with a small roller, which dips so as to be under the surface of the mercury in the cup beneath it. The other plate on the stand has also its cup, which is nearly cylindrical, a metal-pin passes through the bottom of it, to connect by contact with the plate below, and to the inner end of the pin a small round bar-magnet is attached at one pole by thread, so as to allow the other to be above the surface of the mercury when the cup is filled, and have freedom of motion there; a thick wire passes from the rod above down perpendicularly, so as to dip a little way into the mercury of the cup; it forms the connecting-wire, and the pole can move in any direction round it. When the connections are made with the pillar, and either of the wires from the stand-plates, the revolution of the wire, or pole above, takes place; or if the wires be connected with the two coming from the plates, motion takes place in both cups at once."—*Quarterly Journal*, No. 23. p. 186.

II. CHEMISTRY.

10 *Improvement on Wedgwood's Pyrometer.*—The difficulty of procuring clay, which contracts uniformly with heat, has

been long considered as an objection to the ingenious pyrometer, invented and used by Mr Wedgewood. Mr Sivright of Meggetland, has lately made some experiments on the Agalmatolite or figure-stone of China, and has found that it is capable of standing a great heat, and of contracting its dimensions very considerably. He therefore proposes to substitute it in place of clay in Wedgwood's pyrometer.

11. *Spontaneous Explosion of Chlorine and Hydrogen.*—It has been long known that a mixture of chlorine and hydrogen explodes when exposed to the direct action of the sun's rays. In order to try if this effect could be produced by the radiation of a common culinary fire, Professor Silliman filled a common Florence oil-flask (well cleaned,) half full of chlorine gas, and was in the act of introducing the hydrogen in the pneumatic cistern. "There was not only no *direct* emanation from the sun, but even the *diffuse* light was rendered much feebler than common by a thick snow-storm, which had covered the skylight above with a thick mantle, and veiled the heavens in a singular degree for such a storm. Under these circumstances, the hydrogen was scarcely all introduced before the flask exploded with a distinct flame; portions of the glass stuck in the woodwork of the ceiling of the room, and the face and eyes escaped by being out of the direction of the explosion; nothing but the neck of the flask remained in hand. This occurrence then proves, that a mixture of chlorine and hydrogen gas may explode spontaneously even in a diffuse light, and even in a very dim light."—*American Journal of Science*, Vol. III. No. 2. p. 343.

12. *Heat produced in the Skin by Chlorine.*—Dr Hare of Philadelphia has found, that when the temperature of the air is about 60°, the hand, when immersed in chlorine, experiences a sensation of heat equal to 90° or 100°, even though the common thermometer should not be affected when immersed. Dr Hare conjectures, "that a sort of chemical action may take place between [illegible]e gas and the insensible perspiration of the skin, as the power of chlorine in dissolving animal effluvia is well known."—*American Journal of Science*, Vol. III. No. 2. p. 344.

13. *Tests for Arsenic.*—Dr Porter of the University of South Carolina, considering Scheele's Green as a test that has

been much relied on for the discovery of arsenic, prepared it in the usual way with sulphate of copper and subcarbonate of potash. In one experiment a decided precipitate was produced from a *stronger*, and in another a scarcely perceptible one from a *weaker* arsenical solution. Coffee was then added to the solution of copper, and of carbonate of potash, but without arsenic, and the effect resembled that of the stronger arsenical solution, more than this last was resembled by that of the weaker. But what was still more important, Dr Pester found, that in the production of Scheele's green by arsenic, sulphate of copper and carbonate of potash,—*chromate of potash* might be substituted for the arsenic, and that it produced a precipitate not to be distinguished by the eye from Scheele's Green. He ascertained also, that even Mr Hume's celebrated test, nitrate of silver, (as modified in its application by Dr Marcet,) gave with chromate of potash a yellow precipitate, which, when placed side by side with one produced by arsenic, could not be distinguished by their colour and appearance.—*American Journal of Science*, Vol. III. No. 2. p. 354.

14. *Camphor.*—" In the last Number of the Philosophical Journal, you did me the honour to insert some experiments of mine on the Solubility of Phosphorus in Sulphuret of Carbon. Permit me now to add, that if a drop of the sulphuret is brought in contact with a chip of camphor while moving on water, the rotatory motion is instantly checked, and a film of camphor diffuses round the spot to some distance. I have sometimes observed, when a small portion of floating sulphuret of carbon is touched by a minute fragment of camphor, that it glances off with extreme rapidity, and is speedily lost in a rotatory circle. If the camphor, when dropped on the sulphuret of carbon, be too large, both fall together to the bottom of the vessel. Here the camphor is mantled and dissolved by the sulphuret, and the instant the liquid spherule is raised to the surface of the water, it darts a film of camphor around it, and discovers uneven ridges throughout."—J. MURRAY.

15. *Chemical examination of a Liquid from the Crater of Vesuvius.*— " During my sojourn at Naples, I scaled Vesuvius at the period of a slight eruption, and passing a stream of running lava in the crater, got with considerable

hazard into the rent whence the vapours, &c. issued. I there succeeded in collecting a portion of liquid matter, in the act of forming from the condensed vapours, and having sealed the small phial containing it with wax at the burning lava, brought it to this country. The liquid altogether did not amount to more in bulk than about $\frac{1}{8}$th of a fluid ounce, and consequently was too small a portion to determine its numerical constituents. The solid matter deposited by rest from this liquid, I have not yet examined, but it will afford me the opportunity in question; and this substance I may at a future period describe. I mentioned this circumstance to Signor Monticelli, who told me he had observed a similar liquid deposited round the crater after great eruptions, &c. that he presumed it to be a mixture of sulphurous and muriatic acids. This liquid seems to me unusually interesting. It certainly gives no colour whatever to the assumption of a central fire, while it seems to infer some subterranean communication with the waters of the ocean; and we may from hence collect an argument in favour of the Wernerian theory. The lava over which I passed was constantly exhibiting an efflorescence of muriate of soda in cooling, —and this substance I found also encrusting the cavities of the new formed lava, nay, the very atmosphere through which I passed, was highly impregnated with salt. The prickly sensation on the skin denoted its presence, even if it had not been more unequivocally determined by a rigid chemical examination. The liquid was of an amber colour, and of greater specific gravity than distilled water;—a globule sunk in that fluid. The following are the tests to which it was subjected, with their results: Litmus paper was very slightly affected; the salts dissolved seemed almost in a neutral form. Alcohol occasioned a slight opacity, and a sulphate was from hence inferred. The chromate of potassa, proto-nitrate of bismuth, proto-acetate of lead, and nitrous acid, occasioned no change. The nitrate and acetate of baryta denoted the presence of a *sulphate.* The nitrate, acetate, and sulphate of silver, by a copious curdy precipitate, demonstrated the existence of a *muriate.* The tincture of galls, prussiate of potassa and ammonia, and succinate and benzoate of ammonia, clearly demonstrated that *iron* existed. Oxalate and fluate of ammonia proved the existence of *lime* in small quantity. Ammonia, caustic potassa, and bi-carbonate of potassa, with phosphate of soda, gave indications of *magnesia.* Nitro-muriate of platinum gave a slight intimation of *potassa.* Per-muriate of ammonia gave slight traces of *alumina.* No *carbonate* whatever was obtained. From this examination by reagents, therefore, it may be assumed that the chemical constituents of the liquid in question consist of

Sulphate of Lime,
——— of Alumina,
——— of Iron,

Muriate of Soda,
——— of Magnesia,
——— of Potassa.

III. NATURAL HISTORY.

MINERALOGY.

16. *Sulphato-tri-carbonate of Lead.*—A very fine specimen of carbonate of lead was recently brought from Leadhills, by Alexander Irving, Esq., who found it by analysis to be a sulphato-carbonate. Upon examining its crystals, I find it to be the *Sulphato-tri-carbonate* of Mr Brooke *. The crystals, which are of considerable size, are acute rhomboids, with cleavages perpendicular to the axis of the rhomb. They are of a bright sap-green colour. Upon examining their optical structure, I find that they have two axes of double refraction, the principal one of which is coincident with the axis of the rhomb. The sulphato-tri-carbonate, therefore, cannot have the acute Rhomboid for its primitive form, but must belong to the Prismatic system of Mohs.—D. B.

17. *Calc-sinter determined to be true Calcareous-spar.*—The Reverend Dr Fleming of Flisk transmitted to me lately two specimens of this substance, with the following remark: "1. *Lamellar Calc-sinter* from Macalister's Cave in Sky. I procured these crystals in shallow pools in the cave filled with the calcareous water. The indications of crystallization are distinct, but the crystals seem to be but in progress. The summits of the crystals of the smallest piece are smooth and flat, and indicate the prisms below to be five-sided, and sometimes

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* See this Journal, Vol. III. p. 119.

four-sided. I regard these specimens as exceedingly curious, as they are genuine examples of Neptunian calcareous spar. 2. *Acicularly Crystallised fibrous Calc-sinter.*—This substance is from the Isle of Man; the specimen from which these fragments were separated, was given me by Mr Stevenson several years ago, and is interesting as being a recent aqueous formation." Dr Fleming adds, "that all the calcareous matter in Macalister's Cave, whatever be its external form, stalactitic, stalagmitic, or encrusting, is all more or less in the state of calcareous spar, with the usually foliated structure: That which lies in the pools or hollows of the caves has its crystalline forms like those in the specimens sent." Upon examining these interesting specimens, I succeeded in extracting from them regular rhombs of calcareous spar, having their angles of the same value as the finest specimens of carbonate of lime. Their double refraction and their polarising force, were of the same character and the same intensity as the purest Iceland spar. —D. B.

18. *New Mineral from Aachen, near Altenberg.*—Having examined a very fine crystal of *Stilbite* from Aachen, near Altenberg, which Mr Heuland was so kind as to transmit to me., I have found it to differ essentially from all the stilbites, and even from the new species into which Mr Brooke has separated the substances formerly ranked under this name. Since I examined this mineral, I have learned that it is considered by Haüy as a variety of stilbite, to which he gives the name of *Duo-vigesimale.*—D. B.

ZOOLOGY.

19. *On the Spurs of the Ornithorynchus.*—Dr Traill of Liverpool has lately had an opportunity of examining the skins of a male and female ornithorynchus from New South Wales. The spurs of the male were remarkably strong and sharp, and the perforation in them so extremely minute, that it is not surprising that they escaped the notice of the first naturalists who examined them. The tubes were so fine that they would not receive a horse hair, though they admitted a human one.

20. *Horsfield's Zoological Researches.*—Dr Horsfield has just published the first number in quarto of "Zoological Re-

searches in Java and the neighbouring islands." It contains eight plates, four with representations of quadrupeds, and four delineations of birds. The quadrupeds are drawn and engraved on copper by the celebrated artist Daniell, and the birds are drawn on stone by Mr Pelletier. The plates both of quadrupeds and birds are beautifully coloured, and rival in this respect, as also in point of drawing and engraving, the most valued zoological works of this country. The descriptions and observations bear ample testimony to the learning, judgment, and skill of Dr Horsfield, and are so interesting, that we cannot help expressing our regret that the author should limit his work to a single quarto volume of moderate size. The animals described in this number are the following.—*Quadrupeds*: 1. Felis Javanensis. 2. Felis gracilis. 3. Viverra Musango. 4. Tapir Malayanus. This rare and very interesting species resembles in form the American, and has a similar flexible proboscis, somewhat resembling the hog. Daniell's beautiful drawing of the animal conveys a most correct idea of its appearance, and of this we are enabled to judge from a comparison of it with the fine specimen in the Royal Museum of Edinburgh. The following details are given by Dr Horsfield of the history of its discovery: The first intelligence of its existence in Sumatra was given to the Government of Fort Marlborough at Bencoolen, in the year 1772, by Mr Whalfeldt, who was employed in making a survey of the coast. In the month of April of that year, it is noticed in the records, that Mr Whalfeldt laid before the Government his observations on the places southward of Cawoor, where he met with the tapir at the mouth of one of the rivers. He considered it to be the hippopotamus, and described it by that name. Mr Marsden, the distinguished Historian of Sumatra, was at that time at Bencoolen, and the public owes to his zeal in collecting every useful information relating to that island, the first notice of the existence of this animal. After the first discovery in 1772, the tapir was not observed for a considerable period. In the year 1805, a living specimen was sent to Sir George Leith, when Lieutenant-Governor of Prince of Wales' Island. It was afterwards observed by Mr Farquhar, in the vicinity of Malacca. A drawing and description of it were communicated by him to the Asiatic Society in 1816, and a living specimen was afterwards sent to the Menagerie at Barrackpore from Bencoolen. M. Diard, a French gentleman, made a drawing of this specimen, sent it to Paris, where, in March 1819, it was published by M. Fred. Cuvier, in his large lithographic work on the mammalia of the Menagerie of Paris. In the month of September 1820, the first specimen of the Malayan tapir, was received in England from Sir Thomas Raffles, and is now deposited in the valuable museum of the Honourable East India Company. It may be added to this history of Dr Horsfield, that a fine specimen reached the Edinburgh Museum about the same time, as a gift from the Marchioness of Hastings, who has eminently distinguished herself by intelligence, zeal, and activity, in collecting the various natural productions of India.—The *Birds* delineated are the beautiful Fairy roller of Latham, the Irena puella of Horsfield; the Phrenotrix Temea, H.; and a beautiful species of Motacilla, the M. speciosa of Horsfield.

21. *Natural History of the Crinoidea, or Lily-shaped Animals, by J. S. Miller,* A. L. S. 4to, 48 coloured plates.—This curious and interesting work, which is very properly addressed to the members of the Linnean and Geological Societies, contains a minute, at the same time very amusing account, of the crinoid animals so often found in a fossil state in the strata of England, and other countries. It abounds in well executed lithographic drawings and plans of these Crinoidea, and also of the genera Comatula and Marsupites. We have no hesitation in saying it is a work that ought to be in the library of every student of English geology.

22. *Latreille's great Work on the European Coleopterous Insects.*—“A great work on the Natural History of European Coleopterous Insects, has been undertaken by M. Latreille and the Baron Dejean. It would have been difficult to point out among the living naturalists two men that are better qualified for such a task. M. Latreille has been long known as the first of entomologists; but his advanced age, feeble health, and numerous avocations, made him fearful of engaging himself singly in a work which he had often contemplated. He has therefore associated in his labours the Baron Dejean, a French nobleman, who has been for

a series of years in habits of intimate correspondence with all the chief naturalists of Europe. He has made a most useful study of the great collections in Germany, and has been particularly careful in ascertaining correctly the synonyms of the species. His travels in that country, through the Austrian states, in Russia, Spain, Portugal, France, &c. have enriched his cabinet with a prodigious number of insects, of which many are inedited. He possesses nearly 7000 Coleoptera, a number superior to the whole species of that order as described by Fabricius. All the collections in Paris, and particularly that in the Garden of Plants, which contains the insects collected by Olivier in the Morea, the Archipelago, and the Levant, have been laid open to him. M. Latreille, who himself possesses a vast number of rare insects of the south of Europe, will direct the work ; he will mark out the great divisions, verify all the new genera, and afford every assistance to M. Dejean in the specific parts, with which the latter is more particularly engaged. Under such an arrangement success is certain. It is not commenced, like too many works, with feeble supports, in the hope of obtaining, through lapse of time, more effectual aids, and of satisfying the public with numerous supplements. All the materials are collected, and put in order. By means of future researches, these may no doubt be encreased ; but in comparison with the great mass of objects now in hand, such acquisitions will always be inconsiderable, and will never effect any essential change on the methodical distribution adopted by M. Latreille.—When we consider that the number of Coleopterous insects described by Linnæus, scarcely amount to one thousand species, and that we are now acquainted with nearly ten times that number, we shall be forced to admit, that the genera established by that great naturalist ought now to be formed into families, and that it is impossible, without retarding the progress of the science, to adhere to the simplicity of the old method. A brief summary of the most curious and best authenticated particulars will be prefixed to the exposition of each family. The groups will be arranged as much as possible according to their natural affinities, and distinguished, as well as the species, by apposite characters, founded on the comparative examination of the most apparent organs. To the specific name will succeed the synonyms, taken from the works of Linnæus, Geoffroy, De Geer, Fabricius, Olivier, &c. with an indication of the best figure. The more modern works of Gyllenhal, Germar, Sturm, &c. will be likewise cited, and reference made to M. Schönher's excellent work the *Synonymia Insectorum*, in so far as regards the authors of less note. A clear and precise description will strengthen the specific characters; the description of the hitherto unpublished species, though concise, will be more complete; finally, the places where the species are observed, their habits, and periods of appearance, will be carefully indicated. An accurate figure will be given of every species described throughout the work, which will thus be rendered complete, and the possession of other entomological productions rendered unnecessary, in as far as regards the European Coleoptera. It may be added, that almost every series of drawings of insects hitherto executed, has neglected the obscure and least prominent species, of which the determination is the most difficult, as well as the sexual distinctions of many species; and that they have universally been presented either without order, or according to methods extremely artificial and incoherent, and little in harmony with that natural arrangement, which ought alone to obtain the suffrage of the philosophical naturalist.—On calculating the number of European Coleoptera, we find them to amount to about 4800, which, at an average of eight figures to each plate, will give 600 as the probable number of plates illustrative of this work. Each number will contain five plates, and a text descriptive of the species therein figured, forming not less than from two to three sheets of letter-press. The entire work will consist of from fourteen to sixteen volumes, of which two will appear annually. The drawings and engravings are confided to artists the most accomplished in the requisite styles."—*Letter from a Correspondent, dated Paris, Jardin du Roi, October* 1821.

23. *Sea-Snake of the Aleutians, Norwegians, and the Hebridians.*—Pontoppidan describes a monstrous sea-snake said to appear occasionally on the coast of Norway; and relations of a similar description are to be met with in the writings of other authors. Very lately, in the year 1808, the remains of a remarkable animal, answering in some degree to the description of Pontoppidan, was cast ashore on one of the Orkney Islands, and has been described by Dr Barclay in the first

volume of the Memoirs of the Wernerian Natural History Society. In the Memoirs of the same Society, there is an interesting notice by the Rev. Mr Maclean of Small Isles, of an animal supposed to be of this tribe, which was observed near the Island of Eigg, one of the Hebrides; and in the second volume of Kotzebue's Voyage, just published, we have the following notice of a sea-monster said to resemble a serpent: ' M. Kriukoff's description of a sea animal that pursued him at Beering's Island, where he hade gone for the purpose of hunting, is very remarkable: seseveral Aleutians affirm they have often seen this animal. It is of the shape of the red serpent, and is immensely long; the head resembles that of a sea-lion, and two disproportionately large eyes give it a frightful appearance. It was fortunate for us, said Kriukoff, that we were so near the land, or else the monster might have destroyed us: it stretched its head far above the water, looked about for its prey, and vanished. The head soon appeared again, and that considerably nearer: we rowed with all our might, and were very happy to have reached the shore in safety. If a sea-serpent has been really seen on the coast of North America, it may have been one of this frightful species."—Kotzebue's *Voyage*, vol. ii. p 183.

BOTANY.

24. *Red Snow in New South Shetland.*—Snow of a *reddish tint* was found in this region, as in the Arctic countries described by Captain Ross. It appears to owe its colour to some cryptogamic vegetable, probably of the same general nature as that described by Brown and Bauer, in their account of the red snow of the Arctic Highlands.

25. *Tritoma media.*—" I beg leave to state to you, that I got a plant of the *Tritoma media* in the month of October 1818. I did not receive any information respecting its habits, or the manner of treating it; nor did I happen to possess any botanical work which noticed it. I therefore took what I considered at least a safe method. I kept it in a pot in my house during the winter very dry, and in the following May I planted it out in a border with a south exposure. It made little growth till August, when it began to *leaf* freely. About the beginning of October, it put out two lateral shoots from the root, a few inches from the main plant.

In the middle of November, the lower stem began to appear, and it continued to grow till the frost set in. I then put a single light frame over it, which I kept during the severe winter, with occasionally a mat cover. In March 1820 I removed the frame; and as soon as the weather became good, the plant again began to grow, and, in the latter end of April, it was in full flower. I allowed the stem to remain, in hopes that the seed might ripen, but it did not. In June several shoots came up from the running roots, and I found the principal one of the two shoots of last year, which was strong, had become unhealthy. This I lifted, and found that the decay of the old stem had infected it. The other of the two shoots was well rooted, but will not get strong enough to flower this season. I will be careful in future to remove any shoots that are near the stem as soon as the flower is over.—I hope you will obtain information enough to enable you to give directions for the cultivation of this plant, which seems to be a valuable addition to our *flora*."—*Letter from Mr W. Rutherford, Jedburgh, 19th Sept.* 1820. —In several gardens in the neighbourhood of Edinburgh, the Tritoma media (or Aletris sarmentosa) is now cultivated as a border flower. It is found to be perfectly hardy, not requiring any glass cover or other shelter during winter. Like many other natives of the Cape of Good Hope, it flowers here very late in the autumn, or towards our midwinter. It generally happens, indeed, that some flowers appear in November, and some in February; frequently, however, the later flowers receive a check from severe frosts, and are not unfolded till April or May. The principal thing to be attended to in the cultivation of the plant, is the removing of superfluous shoots from the root, and allowing only two or three of the strongest to remain. Treated in this way, the plant never fails to shew its flowers. It should also be transplanted every third or fourth year; and if old hot-bed manure be placed pretty deep below the roots, and the roots themselves be surrounded by fresh light loam, the strength of the flowers and brilliancy of colour will be greatly promoted.

IV. GENERAL SCIENCE.

26. *Methods of Kindling Fire on the Sandwich Islands.*—There are various methods of producing fire. In the Caroline

Islands, a piece of wood being held fast on the ground, another short piece, about a foot and a half long, of the thickness of a thumb, even, as if turned, and with the end bluntly rounded off, is held perpendicularly over it, and put in motion between the palm of the hand, like the mill used for making chocolate. The motion is at first slow, but is accumulated, and the pressure increased, when the dust produced by the friction collects round the bores, and begins to be ignited. This dust is the tinder which takes fire. The women of Eap are said to be uncommonly clever at this process. In Radack and the Sandwich Islands, they hold on the under piece of wood another piece a span long, with a blunt point, at an angle of about thirty degrees, the point of the angle being turned from the person employed. They hold the piece of wood with both hands, the thumbs below, the fingers above, so that it may press firmly and equally, and thus move it backwards and forwards in a straight line, about two or three inches long. When the dust that collects in the groove, produced by the point of the stick, begins to be heated, the pressure and the rapidity of the motion are increased. It is to be observed, that in both methods two pieces of the same kind of wood are used; for which purpose, some of equally fine grains, not too hard, and not too soft, are the best. Both methods require practice, dexterity, and patience. The process of the Aleutians, is the first of these methods, improved by mechanism. They manage the upright stick in the same manner as the gimlet or borer, which they employ in their work. They hold and draw the string, which is twice wound round it, with both hands, the upper end turning in a piece of wood, which they hold with their mouth. In this way, I have seen a piece of fir turned on another piece of fir, produce fire in a few seconds; whereas, in general, a much longer time is required. The Aleutians also make fire by taking two stones, with sulphur rubbed on them, which they strike together over dry moss strewed with sulphur.—Kotzebue's *Voyage*, vol. iii. p. 259.

27. *Earthquake at Inverary.*—An earthquake was distinctly felt at Inverary on the morning of the 22d October. Several persons in the town felt the shock, and others heard a sound

like that of several carriages in motion. About thirteen miles farther down Lochfine, some of the peasantry were much alarmed at seeing their furniture violently shaken. The day was rainy and lowering; and about four o'clock there was a loud and continued peal of thunder, with some vivid flashes of lightning.

28. *Method of illuminating the Dials of Public Clocks with Gas.*—Messrs John and Robert Hart of Glasgow, who have been long known to the public for their scientific acquirements, as well as their practical ingenuity, have erected a very ingenious apparatus for illuminating with gas the dials of the Tron Church and Post-office steeple in Glasgow. "The apparatus consists of a No. 1. Argand burner, placed a few feet out from the top of the dial, and enclosed in a nearly hemispherical lantern, the front of which is glazed,—the back forms a parabolic reflector,—the dial receives not only the direct, but a conical stream of reflected rays, and is thus so brilliantly illuminated, that the hours and hands can be seen with nearly the same distinctness at a distance as through the day. To mask the obtuse appearance of the lantern, its back has been made to assume the form of a spread eagle, above which is placed the city arms, the whole handsomely executed and gilt. The gas-pipe and lantern move on an air-tight joint, so that the lantern may be brought close to the steeple for cleaning when necessary. The gas is *first* ignited by means of a train or flash-pipe, so perforated, that when the gas issuing from the holes at the one end is lighted, the holes along the pipe become so, and thus the gas inside the lantern is kindled as if by a train of dry gunpowder: in this way the light might be first communicated either from the street or from the steeple. The effect of the lighted dial is at once cheerful, pleasant and useful. By a simple contrivance, the clock disengages a small detent, something similar to the larum in wooden clocks. This shuts the gas cock, and instantly extinguishes the light." We should wish to see this apparatus erected in our own city, and we have no doubt that the Gas-Light Company will imitate their friends in Glasgow, by supplying gratis the gas which may be necessary for this purpose.

29. *Lithographic Paper.*—M. Senefelder, the celebrated promoter of the lithographic art, has lately invented a kind of paper

or card, as a substitute for the magnesian limestone usually employed. This card is covered on one or both faces with an argillo-calcareous mixture, which has the property of receiving the ink or the crayon in the same way that the stone does, and of undergoing the ordinary preparation, and furnishing impressions as neat and perfect as those obtained from designs traced on stone. Count Lasteyrie has examined and used this paper, and given a favourable report upon it.

30. *Manufacture of Glass.*—M. Westrumb is said to have found, that the salts of potash and soda, deprived of their water of crystallisation, answer as well as the pure alkali for the manufacture of glass. In order to make an excellent glass, 24 parts of sulphate of soda are thoroughly dried, and mixed with 8 parts of powdered charcoal, and 16 of good white sand. The mixture must be calcined in the drying oven, until the sulphate is dissipated, and is then put into the pots for fusion.—*Annales Gen. de Phys. de Bruxelles*, May 1820.

31. *Dark-brown Streak on the Sea occasioned by Crabs.*—On the 6th December 1815, Captain Kotzebue observed on the the surface of the sea, near the Island of St Catharine, a serpentine streak, about two fathoms broad, of a dark brown colour, which extended as far as the eye could reach. Upon examining it, it was found to be occasioned by an innumerable quantity of small crabs, and the seeds of a marine plant.—Kotzebue's *Voyage of Discovery*, vol. i. p. 113.

32. *Height of the Mountains in Owhyee and Mowee.*—The gigantic height of the mountains of these islands has made them the admiration of navigators. Captain Kotzebue found their height to be as follows:

		Toises.
Island of Owhyee.—	Merino Roa, - -	2482.4
	Merino Kaah, - -	2180.1
	Merino Wororai, - -	1687.1
Island of Mowee.—	Highest Peak, - -	1669.1

Kotzebue's *Voyage of Discovery*, vol. i. p. 318.

33. *Instinct of the Honey-Eater Bird.*—Captain Kotzebue mentions the following circumstance respecting these birds. "The Hottentots, who have a very quick sight, try to observe a bee

flying home with its honey, and pursue it; but they often would not succeed following the bee, were they not assisted by the honey-eater birds, which perceive the intention of the men. The bird now pursues the bee, and gives the Hottentots, who pursue both, a signal by a whistle where the honeycomb is; and when they have taken out the honey, they throw some to the bird, as a reward for his service.—Kotzebue's *Voyage of Discovery*, vol. ii. p. 282.

34. *String Alphabet for the Use of the Blind.*—The string alphabet is formed by so knitting a cord, a ribbon, or the like, that the protuberances made upon it may be qualified by their shape, size, and situation, for signifying the elements of language. The letters of this alphabet are distributed into seven classes, which are distinguished by certain knots or other marks; each class comprehends four letters, except the last, which comprehends but two. The first, or A class, is distinguished by a large round knot; the second, or E class, by a knot projecting from the line; the third, or I class, by the series of links, vulgarly called the drummer's plait; the fourth, or M class, by a simple noose; the fifth, or Q class, by a noose with a line drawn through it; the sixth, or U class, by a noose with a net-knot cast on it; and the seventh, or Y class, by a twisted noose. The first letter of each class is denoted by the simple characteristic of its respective class; the second by the characteristic, and a common knot close to it; the third, by the characteristic and a common knot half an inch from it; and the fourth, by the characteristic and a common knot an inch from it. Thus A is simply a large round knot; B is a large round knot, with a common knot close to it; C is a large round knot, with a common knot half an inch from it; and D is a large round knot, with a common knot an inch from it, and so on.—The alphabet above described, is found by experience to answer completely the purpose for which it was invented. The inventors, Robert Milne and David Macbeath, who are both blind, being in the habit of corresponding by its means, not only with each other, but with several individuals whom they have taught its use. It must readily occur to every one, that the employment of an alphabet composed in the manner which has been explained, will ever be necessarily tedious; but it should be borne in mind, that there is

no supposable system of tangible figures significant of thought, that is not more or less liable to the same objection. The inventors are aware, that among the different methods by which people at a distance might be enabled to hold mutual intercourse through the medium of a language addressed to the touch, there are some that would doubtless be more expeditious than theirs; but they flatter themselves, that when all the advantages and disadvantages of each particular method are duly considered, the plan which they have been led to adopt will appear, upon the whole, decidedly the best. There can scarcely be any system of tangible signs, which it would be less difficult either to learn or to remember; since a person of ordinary intellect may easily acquire a thorough knowledge of the string-alphabet in an hour, and retain it for ever. Yet the inventors can assure their readers, that it is impossible for the pen or the press to convey ideas with greater precision. Besides the highly important properties of simplicity and accuracy which their scheme unites, and in which it has not been surpassed, it possesses various minor, nor yet inconsiderable, advantages, in which, it is presumed, it cannot be equalled by any thing of its kind. For example, its tactile representations of articulate sounds are easily portable,—the materials of which they are constructed may always be procured at a trifling expence,—and the apparatus necessary for their construction is extremely simple. In addition to the letters of the alphabet, there have been contrived arithmetical figures, which, it is hoped, will be of great utility, as the remembrance of numbers is often found peculiarly difficult. Palpable commas, semicolons, &c. have likewise been provided to be used, when judged requisite. The inventors have only to add, that, sensible of the happy results of the invention to themselves, and commiserating the fate of their fellow-prisoners of darkness, they most earnestly recommend to all entrusted with the education of persons deprived of sight, carefully to instruct them in the principles of orthography, as the blind being in general unable to spell, is the chief obstacle to their deriving from the new mode of signifying thought, the much wanted benefit which it is designed to extend to their melancholy circumstances.—Such as are desirous of further information respecting the String Alphabet, &c. may obtain it by applying to David Macbeath, Blind Asylum, Nicolson Street, or to Robert Milne, music-teacher, No. 28. Broughton Street, Edinburgh *.

35. *Luminosity of the Sea.*—I am very glad to see that my views on the luminosity of the sea accord strikingly with those of Dr MacCulloch, agreeably to his paper inserted in Mr Brande's Quarterly Journal of Science and the Arts, No. 22., for July last. Pages 250, 253, 255, and 256, particularly corroborate my remarks; and it may be proper to remark, that my paper "on the Luminosity of the Sea," published in the third volume of the Transactions of the Wernerian Society, was transmitted and read before that Society in 1819.—J. MURRAY.

ART. XXXIV.—*List of Patents granted in Scotland since 1st September* 1821.

18. TO WILLIAM ALDERSEY of Homerton, in the parish of Hackney, county of Middlesex, gentleman, for "An Improvement in Steam-Engines and other Machinery, where the Crank is used." Sealed at Edinburgh the 19th September 1821.

19. To DAVID GORDON of the city of Edinburgh, in the county of Edinburgh, at present residing in the burgh of Stranraer, Esq. for "certain Improvements in the Construction of Harness for Animals of Draught and Burden." Sealed at Edinburgh the 19th November 1821.

20. To GEORGE VAUGHAN, late of Sheffield, in the county of York, gentleman, now of Chesterfield, in the county of Derby, for his "Invention of a Blowing Machine, on a new construction, for the fusing and heating of metals, smelting of ores, and supplying blast for various other purposes." Sealed at Edinburgh the 17th November 1821.

21. To CHARLES PHILLIPS of Albemarle Street, Piccadilly, county of Middlesex, Commander in the Navy, for "certain Improvements in the Apparatus for propelling Vessels, and an Improvement in the Construction of Vessels so propelled." Sealed at Edinburgh the 17th November 1821.

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* The above notice, which is the composition of the inventors themselves, has been printed without any alteration.

P NEILL, Printer.

THE

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PHILOSOPHICAL JOURNAL.

ART. I.—*History of the Invention of Pendulum Clocks by* CHRISTIAN HUYGENS *. By J. H. VAN SWINDEN, Councillor of State, Professor of Philosophy at Amsterdam, &c.

THE measure of time is of the greatest importance to civil society, and in many departments of science. An accurate one, capable of measuring its minutest parts, is essentially necessary for astronomy. Accordingly, different contrivances for this purpose have been of old devised; such as the clepsydræ of the ancients,—to which were substituted the motion of sand,—and afterwards clocks, furnished with wheels, and moved by a weight or spring. The latter were materially improved by the introduction of a *balance*, which regulated to a certain degree the motion of the wheels. Still the irregularities to which even the best of them were subject, were so great, that the most famous astronomers, such as Tycho Brahé and Hevelius, though they spared no trouble or expence in their construction, were compelled to acknowledge that no dependence could be placed upon them.

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* The following is a somewhat abridged translation of a paper read before the First Class of the Dutch Institute, and inserted in the Third Volume of their Memoirs. Its chief value for the history of Science, consists in the number of hitherto unpublished documents which the author has collected from the manuscript papers relating to Huygens in the possession of the University of Leyden, of which large extracts are appended to the memoir. These are not attempted to be given here, but may be consulted by every one, being for the most part written in the original French and Latin languages. They are referred to in the translation by the words *Leyden* MSS. Short extracts of them have, however, been occasionally added in the notes, or incorporated with the text.—TRANSL.

The use which might be derived from the oscillations of a vibrating body, first became apparent to astronomers, from the time that Galileo made known his theory of pendulums, partly by his letters, and *Systema Cosmicum*, published in Italian in 1632, but more especially by his *Dialogi de Motu*, which appeared in 1639. They applied this doctrine to measure the time which elapsed between two observations, by means of a ball, suspended to a wire or metallic rod, which oscillated by its own gravity when impelled; and we are truly astonished at the degree of accuracy of which this method became susceptible, in the hands of diligent observers. It was, however, subject to two serious inconveniences. The principal one was the necessity of assistants to count the number of oscillations of the pendulum, relieving each other at intervals, as the length of the observation, which sometimes lasted for twenty-four hours, required. This made some of them intent on the possibility of adapting to the pendulum something which might of itself indicate how many oscillations had taken place during the interval of observations. Hevelius affirms having succeeded in such a contrivance, (*Machina Cœlestis*, i. p. 364.); and Wallis, in a letter to Huygens, (*Leyden* MSS), says that somebody had added a wheel to his pendulum, which served the same purpose. Another defect consisted in these pendulums always returning to rest, after describing arcs which became continually shorter and shorter, so that after a certain period they required being put in motion again. Pendulums, then, in this state, could not be termed *accurate measurers of time* In order to answer this end, some additional contrivance was requisite, which should, by its action, restore to the pendulum the loss of velocity suffered at each vibration, and thus render its motion perpetual, whilst itself should in its turn be kept to a regular rate, by being obliged to follow the isochronous beats of the pendulum, and become capable of showing off with accuracy, not only the smallest portions of time, but in like manner those longer periods which arise from the accumulation of them.

This required a genius of a particular cast. It appeared in the person of our countryman CHRISTIAN HUYGENS, a man of rare talents, who, when yet very young, was already ranked among the first mathematicians of his age, and is still considered as one of the greatest that ever lived, and who, from his earliest studies, showed a turn for mechanics, which, united to his theoretical knowledge, peculiarly fitted him for the accomplishment of this difficult task. It was at the latter end of the year 1656, that Huygens first hit upon the idea of furnishing clockwork with a pendulum, and substituting the latter for the *balances* then in use. He immediately set about making one of this construction, and had many more made under his direction in 1657, for which he obtained, on the 16th of June, an exclusive privilege from the States-General. In 1658, he published a Latin description of his clocks, consisting of a few pages in quarto, under the title of *Horologium*, dedicated to the States of Holland. He also made known his invention to many of his friends, as appears from their numerous answers (*Leyden* MSS.), and he made an unsuccessful attempt to procure a similar patent in France. Scarcely had he constructed a few on this principle, till they were every where brought into use: the balances of many clocks, whether driven by a weight or a spring, were taken out, and pendulums substituted in their place; so that even before the above-mentioned Latin publication appeared, clocks were seen, having pendulums of twelve or twenty feet long, with weights upwards of thirty pounds affixed to them *, of which those of the church at the village of Scheveningen, near the Hague, and at Utrecht, may be reckoned among the first. His description of them was sent to his correspondents among the learned, and by them diffused in every foreign country, and spread with amazing rapidity. The proofs of this assertion are most evident, from the numerous congratulatory epistles addressed to him on the occasion, from people of all ranks and countries, accompanied with frequent requests of sending specimens of his newly invented clock, as constructed under his own

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* *Horologium*, p. 1. & 9.—The works of Huygens were first collected by s'Gravesande, under the title of *Huygenii Opera varia*, 1724, in quarto, with an account of his life prefixed; to which were added by the same, *Opera Reliqua et Posthuma*, in 1728.

superintendence, (*Leyden* MSS.)*; and astronomers from thence began to relinquish their former balance apparatus, which was soon entirely superseded by the pendulum clock.

Notwithstanding the important discovery thus made, it was to be expected, at a time when the application of mathematical theories to mechanics was far from being generally understood, that the principle of the new contrivance, namely, the reciprocal action of the wheels and pendulum on each other, (the latter regulating the former, whilst it is prevented by them from returning to rest,) would not be immediately and fully comprehended by all, but give rise to several objections. We must therefore enter into a more particular detail of the uses and construction of the balances, for which the pendulum came to be substituted, in order to show how greatly the old principle fell short of the new, in answering the end of a proper regulator of the work, confining our attention to that part of clockwork to which the invention more immediately belonged, and which is called the *Escapement.*

The old works, then, may in this respect be reduced to two classes. In the first, Fig. 3. Plate VII. the balance TT was supported on a perpendicular arbor MN, the pallets M and N of which acted on the teeth of an upright crown or balance-wheel LL. When Huygens substituted the pendulum, he only at first altered this arrangement, in so far that he fixed on the perpendicular arbor MN, Fig. 1. a pinion, or smaller wheel O, which not having a revolving but swinging motion, as well as the arbor itself, engaged by its leaves the teeth of a larger wheel P, supported on the horizontal part of the bent wire TQR, which transmitted the reciprocal actions of the pendulum and clockwork. By this contrivance, and because the diameter of the wheel P was double or treble of that of the pinion O, Huygens judged that small vibrations of the pendulum would keep the clock going, and that small irregularities in its motion could not disturb the uniform rate or isochronism of the work†,—an explanation with which Wallis, who had at first entertained a doubt on this head, expresses himself perfectly satisfied. (*Leyden* MSS).

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* Among these are letters of Mylon and Bouillan, distinguished mathematicians at Paris, Wallis, Jacquet, Gregorius a Sancto Vincentio, Kinner of Vienna, Slusius, and Pascal.

† *Horologium*, p. 12.—Fig. 1. is taken from the diagram affixed to the Horologium; only those parts are omitted which do not immediately concern the escape-

The second class of clockworks, Fig. 4. had the axis to which the pallets were affixed in a horizontal situation, whilst the balance TT moved in a vertical plane. In subsequently adopting this arrangement Fig. 2., it seems that the vibrations of the pendulum now directly receiving the impulse of the pallets, became too large, and that it was in order to obviate this defect that Huygens suspended the pendulum from a thread between two curved brass-plates, which, by arresting it at a certain point of its course, prevented its going too far on either side. This departure from the original construction was not then published by Huygens; but it must have occurred to him very soon after the publication of the first, whether with a view of adapting the new principle more easily to the then existing balance-works, or as a farther improvement of his own, (his activity and endeavours after perfection knowing no bounds, *nil actum reputans si quid superesset agendum*); for, in a letter of M. Mylon, dated Paris, 31st January 1659, this gentleman speaks of clocks, in which the axis lies horizontal, which, not having the pinion and wheel O, P, Fig. 1, are freed from certain inconveniences, but are liable to another, " which," he says, " namely the inequality of the lengths of the vibrations, and consequently of the time, you have endeavoured to correct, by the addition of those two small pieces." (*Leyden* MSS.) And Huygens himself, in a letter to Van Schooten, Professor at Leyden, of the 6th December 1659, says: " You know, I think, that I employed in my clockworks two curved plates, between which the pendulum moved; and that this was done, in order that the vibrations might all be made in equal times, as otherwise they would not be isochronous." After he had used them for this purpose, he discovered,

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ment. The improved arrangement represented in Fig. 2. is taken from his work on the Theory of Pendulums, entitled *Horologium Oscillatorium*, which Huygens only published in 1673, though, (as will appear in the text), it had occurred to him at a much earlier period, and was actually adopted soon after the discovery of the first. It must be observed, however, that the plates or cheeks, between which the pendulum is suspended, were not at first of the cycloidal shape, which he afterwards adopted and explained in this latter work, but were intended for a different use, which is explained in the sequel.

that, in order completely to answer their end, they must be bent into cycloidal arcs, a discovery which he communicates in the same letter: "Quod igitur nunquam me inventurum speraveram, nunc denique reperi: veram nimirum figuram curvarum, quæ efficiat ut oscillationes omnes accuratissime exæquentur. Eam *ratione geometrica* determinavi —— mihi quidem omnium felicissima (inventio) videtur in quas unquam inciderim." (*Leyden* MSS).

The decided advantages of the pendulum over the old balances to regulate the rate of clocks, were not however immediately perceived by all. In the first place, it was thought by some, that as clocks furnished with balances moved faster, according as heavier weights impelled the wheels, the same might be the case with pendulum-clocks. In the next place, balance-clocks stood still on being wound up, whereas Huygens, by his mode of suspending the weights, made his move on during this operation. In the third place, the reciprocal actions of the pallets and crown-wheel appear not to have been thoroughly understood by many. They imagined, that the irregularities in the motion of the wheels might perhaps in this manner communicate themselves to the pendulum, instead of being overruled and prevented by it *. Lastly, the inequalities in the lengths of the vibrations would alter the isochronism, an objection which Huygens was himself the first to make; but he shows at the same time that his manner of connecting the pendulum with the work, made these small anomalies imperceptible (*Horologium*, p. 12.)

The attention of astronomers about this time was generally directed towards finding some means of rendering clocks more regular. Hevelius, who had already, it seems, devised some method by which the pendulum itself might indicate the number of oscillations it had gone through during a certain time, appears likewise to have been intent on the means of rendering its motion perpetual, and even to have *endeavoured* to connect it with his clocks: "But," he adds, "whilst working at them, and before they were completely finished, it happened that Huygens had in 1657 invented *similar* clocks, and published a description of them in 1658." (*Machina Cœlestis*, p. 366.) In a manuscript paper in Huygens's own hand, containing short remarks on his principal discoveries, under the title of *Anecdota*, (*Leyden* MSS.). he only says of Hevelius, that he had made attempts for himself "Hevelius sibi occœpit." Hook appears likewise to have found out a means of rendering the motion of pendulums perpetual, but it was no application of them to regulate clocks. (*Hook's* Works in fol. p. 4.) Many, in short, sought after something,—Huygens alone hit upon the true principle. He was far from denying, however, that the loose or detached pendulums brought into use for astronomical purposes by Galileo, had suggested to him the use which might be made of them to regulate clocks, (*Horologium*, p. 1.); nor did he conceal that the common balance-clocks prevalent at that time, had furnished the ground of the escapement, and that he only altered them so far as was necessary to adapt them to the action of the new regulating principle. (*Ibid.* p. 7.)

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* Abundant proofs of this occur in the letters of his correspondents, (*Leyden* MSS). The objection is stated in the most forcible manner by Jucquet, in a letter from ntwerp, 1658: "*Unus mihi scrupulus inhærit, pendulum tuum non tam suo, quam automati motu, cieri.* Cum enim pendulum liberum neque vibrationum arcus sortiatur æquales, neque motum per se continuet, utrumque autem tui automati beneficio consequatur, manifestum videtur illud agitari potius automati motu artificiali quam naturali suo.——Manet dubium annon plus inæqualitatis de machina in motum penduli, quam æqualitatis ex motu penduli in machina derivetur," &c.

The description given by Huygens of his clocks, as likewise the clocks constructed by him, or under his inspection, soon taught clockmakers here and elsewhere to substitute the pendulum for the balance in existing works. Many, however, did not succeed so easily *; and although Wallis wrote Huygens, (*Leyden* MSS.) that, before receiving his description, he had seen in England a clock with a pendulum, which was, however, known to be of his invention, and added, in a subsequent letter, that several English watchmakers imitated them each in his way, from which it would appear, that, very soon after the invention, pendulum-clocks were constructed in England; still the number of them must have been small: for Derham, an Englishman, who published a work on watchmaking in 1700, says, that after Huygens had invented pendulum-clocks, and made many of them, a Dutch watchmaker of the name of Fromentil came over from Holland about the year 1662, and constructed the first ever seen in England. He adds, that there was still one extant in Gresham College, which Bishop Seth of Salisbury had made a present of to the London Society. This, however, I am disposed to think relates only to pendulums with cycloidal cheeks. Huygens himself mentions, in a journal of his voyage to England in 1661, that Mr Goddart had, on the 6th of April of that year, at a meeting of the Society at Gresham College, shewn him in his apartments three fine pendulum-clocks.

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* The numerous letters of M. Petit, Intendant des Fortifications et Ingénieur du Roi, to M. Huygens, form an amusing part of the collection in the Leyden MSS. He could not for a long time succeed in fitting up a clock in his possession, so as to make it go; and though he wrote letter after letter for advice, and added weight after weight to move the wheels, his difficulties seemed rather to increase; and he was for several years the most troublesome correspondent of Huygens, whom he professed to admire very much.—*Note of the Translator.*

Some watchmakers in Holland, who, notwithstanding the privilege of the States granted to Huygens, imitated his pieces, concealed as much as possible the new device, and went even so far as entirely to dispute his claim to the discovery. He complains of this abuse in the dedication to the States of Holland, prefixed to the Horologium; and was even compelled to prove his claims in a lawsuit, which he directed his workman Coster to institute against a watchmaker at Rotterdam.

This, which took place in Holland under Huygens's eye, was much more to be expected in foreign parts, and actually happened at Rome, where the description published by Huygens had been sent at the end of 1658. Ægidius Gottignies, a professor at the latter place, wrote in August 1659 to Gregorius à Sancto Vincentio at Ghent: "One of these days, a watchmaker to the Pope constructed a clock similar to that of which Huygens sent you the description. He was highly elated with this new and admirable invention, which he said was his own, and had asked all mathematicians to come and see it. All were loud in their praises. For as he had prudently concealed the chief contrivance, so that the spectators saw nothing but the hands and pendulum, they were astonished, and could not sufficiently testify their admiration of a thing of which they had heard nothing, and bestowed the greatest applause on the pretended discoverer, when I, who had been admitted among them by Father Athanasius Kircher, suddenly checked these plaudits, by mentioning the name of the author, and exposing the hidden artifice. Father Kircher has asked me to instruct a workman how to make such a clock, which I undertook to do." (*Leyden* MSS.)

But we come to more serious attacks on the rights of Huygens to be considered the inventor of pendulum-clocks. These arose more especially in Italy, where the invention has been ascribed to Galileus Galilei, and his son Vincenzio Galilei. As this claim has been asserted in several works, even of the present day, and with some appearance of reason, it becomes necessary to show, from original documents, how far Galileo and his son had gone, and to examine the real truth of the abovementioned assertions. This is the chief purpose of this paper; and I flatter myself to be able to set the whole matter at rest for ever; and, far from detracting any thing from the just claims of Galileo, to place these, on the contrary, in their proper light, by pointing out, in a much clearer manner than has ever yet been done, what Galileo actually accomplished.

I shall first state the nature of the claims set up against Huygens, before entering upon a critical examination of them.

They may be learned from the introduction to the *Horologium Oscillatorium*, published in 1673, where, in a firm, though moderate manner, he asserts his right to the honour of the discovery, "Nunc cum hæc omnibus nota sint, (namely, that he, Huygens, had fitted up clocks with a pendulum as early as 1657, and sent specimens of them, along with a printed description, every where the following year,) facile apparet quid de illis existimandum sit qui septem post annis eandem constructionem, quasi a se suisve amicis profectam libris suis venditarunt." It was probably after reading these words, that Prince Leopold de Medicis wrote in 1673, the letter quoted by Tiraboschi, from the *Lettre inedite d'Uomini ill.*, and addressed to Huygens: "*Per quello che riguarde all' invenzione del pendole, con asserzione dettata da animo sincerissimo, costantemente le affirmo di credere mosso da un forte verosimile, che à notizia di v. s. non sia per alcun tempo venuto il concetto, che sovvenne ancora al nostro Galileo di adattare il pendolo all' oriolo; poiche ciò era e pochissimi noto, et l'istesso Galileo non avea ridatto all' atto practico cosa veruna di perfetto, a tel conto, come si vede* *da quel poco che fu manupulato ed abbozata dal figliuolo.*" To which Huygens, according to the same writer, would have answered: "*Il faut bien croire pourtant, puisqu'un tel Prince l'assure, que Galiléo ait eu' auparavant moi cette pensée.*" (*Storia della litteratura Italiana*, t. viii. p. 156.) This letter of the Prince I have not found among the papers in my hands. The words above quoted from Huygens, relate to what Count Malvasia had published in his *Ephemerides*, printed in 1662 at Florence, that he possessed at his house a clock, "the motion of which was regulated by a pendulum, *according to the manner discovered at Florence some years before.*" This does not prove that this clock existed before the publication of Huygens's description, but merely that Malvasia considered the application of pendulums to clocks as an invention of the Florentines Nor does he attribute it directly to Galileo; but he certainly takes it away from Huygens. That the Florentines claimed the discovery, was not new to the latter, since, already two years before, he had received from Rome a letter, (dated March 1660,) in which the writer informs him, that he had heard at Florence that pendulum-clocks had been invented there for some time, and that somebody had even sketched out to him in a rough manner what Galileo had *attempted* to make on that principle. Nor was he ignorant of what Prince Leopold de Medicis wrote in April 1659, to Bouillan at Paris, from whom he had received a copy of the description of Huygens, namely, that the application of the pendulum to clocks had been a subject attended to at Florence for three years, and that an artist had made a clock, which he (the Prince) hoped would succeed. Consequently this work had not yet been perfectly finished. Extracts of that letter were sent to him by Bouillan, (*Leyden* MSS.) and this latter gentleman, upon receiving Huygens's answer, expresses himself highly satisfied with it, and sent his own words to the Prince, who, in a subsequent letter, acquits Huygens entirely of the charge of having wilfully attributed to himself the discovery of Galileo, (*Ib.*). This defence of Huygens to Bouillan would throw much light on the subject; unfortunately it has not come down to us, and he himself seldom kept minutes of his letters; but very rarely we find short remarks subjoined to letters which he had received, and which probably contained an outline of the answers he had made to them.

What follows relates no doubt to the statement found in the account of experiments made at Florence, under the title of *Saggi di Naturali Experiensi*, which had appeared in 1667, "Qui vero Galileo primas hic deferre conantur, si tentasse eum, non vero perfecisse inventum dicant, illius magis quam meæ laudi detrahere videntur, quippe qui rem eandem meliori quam ille eventu investigaverim. Cum autem vel ab ipso Galileo, vel ab ipsius filio, quod nuper voluit vir quidam eruditus, ad exitum perductum fuisse contendunt, horologiumque ejusmodi re ipsa adhibitum, nescio quomodo creditum sibi iri sperent, cum vix verisimile sit adeo utile inventum ignotum manere potuisse annis totis octo (1649,—1657,) donec a me in lucem ederetur." (*Horol. Oscillator.*, p. 32.) The Secretary of the Academy del Cimento, then Count Lorenzo Magalotti, had said, p. 22. of the *Saggi* *, that the academicians (in order to measure the time accurately,) had "thought proper to add a pendulum to a clock, after the *example* of what Galileo had found out *the first of all*, and his son, Vincenzio Galileo, had put in practice as early as 1649." The claims of Galileo to the invention could not possibly be asserted in stronger terms. A figure is added of the clock, as employed by the academicians of Florence, but this only shows the external appearance of the instrument; besides they do not tell us whether this agrees exactly with the original, as constructed by Vincenzio Galileo, and pendulum-clocks existed already at the period of this publication in Italy, where the description by Huygens was likewise every where known.

This is not all. In 1680 appeared a man, who roundly denied that Huygens ever made any discovery about clocks at all. This was no other than Becker, well known for having originally suggested the system which so long prevailed under the name of Stahl. In February of that year, he presented to the Royal Society of London a treatise *De Nova Temporis dime-*

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* This work, in folio, was translated into Latin, with notes, by Musschenbroek, and published in 1731, under the title of *Tentamina Naturalia Academiæ Al Cimento*, in quarto.

*tiendi ratione, et accurata horologiorum ratione**, in which he thus expresses himself: "M. Huygens of Zuilichem, a Hollander, claims the invention and practical application of pendulum-clocks, in his treatise dedicated to the States of Holland, from which he afterwards obtained an exclusive privilege, as likewise from the King of France:' (This is inaccurate; the privilege was of the States-General, and granted the year *before* the publication; nor did he obtain the privilege from the King of France, though he applied for it). "But Count Magalotti, Resident on the part of the Grand Duke of Tuscany at the Imperial Court, contradicts him, who told me in person the whole history of that clock; the same was told me three years ago in the same manner at Augsburg by Trefler, watchmaker of the late Grand Duke †, father of the present. Namely he relates having, by order of the Grand Duke, and in the spirit *(instinctu)* of his mathematician Galileo Galilei, made the first pendulum-clock *(Horologium Pendulum)* at Florence, of which a specimen was sent to Holland. The mathematician of the late Elector of Mentz, told me he had seen at Prague a pendulum-clock, made by Justus Borgen, mathematician and watchmaker to the Emperor Rudolph II., of which the great mathematician, Tycho Brahé, had made use in his astronomical observations." This statement of Becker has found its way into several works, and has been admitted, without farther inquiry, by some as containing facts uncontroverted by any species of evidence, except the known integrity of Huygens, by others as undoubted truth, and farther commented upon in an eulogy on Galileo, originally published at Milan, in an Italian Journal *del Caffè*, afterwards in the third volume of *Elogi degli Uomini illustri di Toscana*, printed at Lucca in 1772. The writer of this last work, in mentioning that Galileo, in his old age, had added a pendulum to clocks, after adding the words of Becker and those of Magalotti, in the Experiments of the Academy *del Cimento*, concludes thus: "Lastly, We possess the letters of Galileo to Beaugrand, with others of Reaal and Hortensius, which, besides Viviani, prove, in an indubitable manner, that Galileo really made the application of the pendulum to clocks. It is Elia Deodati, who, in 1637, sent an account to the father of the celebrated Huygens, of the pendulum-clocks constructed by Galileo; and Becker adds, that a model was likewise sent to Holland. All this is sufficient to refute Huygens, Musschenbröek, and many others, who will not allow Italy the honour of these great discoveries*."

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* Reprinted in the *Physica Subterranea.* The judgment of Flamstead and Hook upon it was any thing but favourable. See Birch's *Hist. of the Royal Soc.* iv. 17. Leibnitz drew a still worse picture of the man, Op. vi. 333. His language about Huygens appears certainly not very creditable, after he had, in 1660, on a visit to Holland, requested the honour of his acquaintance, to shew him a *perpetuum mobile*, with some little flattery to a man, "Quem in Mechanicis ob Ho[illegible]gium a te (Huygenio) inventum celebrari intellexit." (*Leyden* MSS.)

† Ferdinand II. dead in 1670; he was brother of Leopold de Medicis, before mentioned.

It is impossible to meet with more unqualified charges, and if, after the lapse of centuries, nothing should remain on the subject but the writings of Becker and of this eulogist, one would be compelled to refuse Huygens all share in the application of the pendulum, and perhaps to refer it to an earlier period than Galileo himself,—so difficult it is sometimes to ascertain the truth in the history of science. What, then, are we to think of the opinions of older philosophers, as described by historians, panegyrists, and other writers, when such uncertainty exists respecting a discovery a little more than one century and a half old?

To these bold assertions I shall now oppose the evidence of *facts*, which I have arranged under the five following heads:

In the *first* place, By showing that the correspondence of Galileo contains not a word of the pretended application of the pendulum to clocks.

Secondly, By disproving, what is hinted at, that Huygens learnt the application made by Galileo through the letters of his father, or by a model from Italy.

Thirdly, By exhibiting, what has never been done yet, the actual clock, as devised or made by Galilei and his son Vicenzio, from papers hitherto unpublished, and shewing that Huygens neither had nor could have the least knowledge of it. This, I believe, will show Galileo to have accomplished even something more than what his most zealous defenders have brought forward to this day.

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* This work on Galileo has been literally copied in the Geneva edition of the *Encyclopédie*, in quarto, by Pellet, and the octavo edition, under the word *Galileo*, where it is attributed to Frisi. This is false; the *Elogio de Galileo* by Frisi, of which more hereafter, is a totally different work, and contains altogether different views from those here expressed.

Fourthly, By proving the narrative respecting Trefler in Becker's work to be greatly exaggerated, and that the most probable circumstances in it must, from their very nature, have been unknown to Huygens.

And, *lastly*, By explaining the origin of those pretended pendulum-clocks employed, it is said, by Tycho Brahé, whose death had taken place more than thirty years before any thing respecting Galileo's attempts were made known.

1. With regard to the letters of Galileo to Beaugrand, there is found but *one* in the quarto edition of his works in Italian of 1718, dated November 1633, in which, speaking of the longitude, he mentions the necessity of having accurate clocks, *(giusto orologio,)* " which I construct with so much facility, precision and simplicity, that they do not admit of an error of a single second, not only in an hour, but even in a day in a month." Whether there be others in the *Lettre inedite d'Uomini illustri*, by Fabroni, I have not been able to ascertain; but they cannot possibly contain more information than those which we are next to examine, and which were written professedly on the subject hinted at in the above letter to Beaugrand.

These are addressed to Reaal, formerly Governor of India, a man of great merit, knowledge, and authority in Holland. Hortensius, Profeſsor of Mathematics at Amsterdam, the celebrated Grotius, and the States-General, and relate all to the discovery which Galileo had made of the Satellites of Jupiter, their eclipses, and his method of finding the longitude by means of them. After having applied in vain for the support and countenance of the Court of Spain, he resolved, in 1635, to offer his discovery to the States-General of the United Provinces. This correspondence, which was carried on chiefly through the medium of Deodati, at Paris, and Grotius, is contained in his works, to which may be added the *Epistolæ Grotii.* In his first communication of March 1636 to the States, he enumerates the requisites for making a good observation at sea, and mentions as one an excellent clock " (*esquisito orologio,*) to count the hour, with its smallest divisions, (*minurie,*)" from noon, or from the setting of the sun. Of which he says, "I possess *measures of time* (*mesuratore del tempo*) such, that if one constructs four or six similar instruments, one will find, as a proof of their accuracy, that the times which they measure and indicate (*tempi da quelli mesurati è mostrati,*) do not differ one second, not only in an hour, but a day, a month; so uniform are these *clocks* (*oruoli,*) fully (*pur troppo*) astonishing to observers of celestial phenomena and motions; the more because the construction of those instruments (*instrumenti*) is very easy and simple, and little subject to those external hindrances which other instruments devised for the same purpose are liable to." The word *oruoli* (horologes,) which here occurs, must be particularly attended to; for though it suggests to us, and did even suggest at that time the idea of an instrument indicating the time by the regular motion of the hands, it appears from Galileo's own description of them, in a subsequent letter, written in June of the same year, that he meant something quite different from it. After explaining the chief principles of this theory of the pendulum from his *Dialogi de Motu,* (which were then printing at Elzevir's,) he adds: "From these true and well established principles, I derived the construction of my *reckoners* of time (*numeratore del tempo*), and I use not a weight suspended by a thread, but a pendulum (*pendole*) of some ponderous and more solid stuff, (*de materia solida è grave,*) as brass or copper: I make the pendulum in the form of a sector of twelve or fifteen degrees, its semidiameter of two or three palms, (between sixteen and twenty-four inches,) the larger it is the more easy will it be to be employed (*con minor tedio se gli potra assistere*). I make this sector thick in the semidiameter of the middle, and becoming thinner towards the edge, by which means I obtain a cutting side, which will enable it to overcome, as much as possible, the resistance of the air, which alone retards its motion. In the centre is a hole through which an iron axis passes, like that of a balance, with a sharp edge below, resting on two supports of bell-metal." "It will be necessary," he farther adds, "in order to continue its motion, that an assistant shall, from time to time, give it a pretty strong impulse, (*un impulso gagliardo*), to restore the length of its vibrations." But as the same assistant has to count the number of oscillations which it performs, he proposes, as a tolerably easy mode of avoiding this troublesome labour, (*un assai commodo provredimento,*) that from the middle of the vibrating sector there should project a pin, which, when the pendulum swings to one side, should meet the upright part of a tooth belonging to a small crown-wheel, as light as paper, (*leggicrissima quanto una carta,*) and impel it round its axis, but on swinging backwards, ascend along the sloping side of the same tooth, and leave the wheel unmoved; so that one tooth might be impelled at each entire vibration, and the number of vibrations be shewn by the revolution of the wheel, which might likewise be connected with a larger wheel by means of a pinion." "But," he adds, "it is unnecessary to explain all this to you, who possess choice and practised artists in the construction of clocks and other machines; because those people, on learning the new principle, that a pendulum performs its oscillations in very equal times, whether it describes larger or smaller arches, will be able to draw from it much more *subtile* consequences than I can imagine." From this it appears doubtful, whether Galileo ever himself tried the contrivance of the pin and wheel, and did not rather throw it out as a hint for others to improve upon, than as the result of actual experience. He then concludes in these remarkable words: "In these very simple pendulums, then, which are subject to no alteration whatever, (*alterazione alcune,*) is contained the method to preserve in an easy manner a constant measure of time: and you will perceive their utility and the advantages they possess in astronomical observations, which do not require that the *oruolo* should always go, but where it is sufficient to know from the hours of noon, or of the setting of the sun, the smaller divisions of time, for an eclipse, conjunction, or other celestial phenomenon."

These extracts need no comment. They prove abundantly that the word *oruolo,* though used long before that period, to express a clock moved by wheels and weights, was the name adopted by Galileo to designate this loose pendulum, the invention of which, as the measure of time, belongs undoubtedly to him. That it continued to be called by that name for some years after, is manifest from a French work, printed at Paris in 1639, bearing the title *L'usage des Quadrans ou de l'Horologe Physique Universel*, and which treats of nothing but free or detached pendulums; it is in fact an extract from the Theory of Galileo.

The States-General, on receiving the propositions of Galileo, appointed Commissioners to examine them, presented him with a golden chain, as a token of their regard, and promised greater rewards, if the invention should be found to succeed. The negociations, however, were interrupted by the successive deaths of all the Commissioners, and finally put a stop to by his own death, which happened in 1641.

I conclude, then, that those who appeal to the correspondence of Galileo, have either not examined the letters, or been deceived by the twofold circumstance of his employing a pendulum, and calling it by the name of *Oruolo;* and that at least from 1636 to 1639, Galileo had not yet either accomplished or indicated the application of the pendulum to regulate the motion of clockwork.

(To be concluded in next Number.)

ART. II.—*Observations on the Countries of Congo and Loango, as in* 1790. By Mr MAXWELL, Author of the Letters to MUNGO PARK, &c. &c. (Concluded from Vol. VI. p. 62.)

CANOES.—AT Cape Lopez and Jabon, the canoes are formed out of single trees of red-wood. They are flat-bottomed and wall-sided I have seen some of them seventy feet long, six broad, and four deep, capable of holding a considerable number of people. I am told of one belonging to King Passeall, at Cape Lopez, that holds two hundred men.

HOUSES.—The construction of these, though simple, is very ingenious. The body of the house consists of four parts, the ends and sides, each made separately of bulrush-stems. The bulrushes, which are about an inch in diameter, are first cut of the proper length, and laid parallel to one another upon the ground; they are then secured in this position by transverse branches of bamboo at the ends and in the middle, three or each side, which are firmly bound together by slips of the palmetto leaf. In one end, a square opening is left for the door. The frame-work thus completed, is fastened to four upright posts driven into the ground, and is then ready to receive the roof, which is made of bamboo or palm-leaves overlapping each other: it consists of two parts, attached to each other by a sort of hinge, for the purpose of being folded together when the family removes. The best houses seldom exceed twenty feet in length, and twelve in breadth; the sides are about seven feet high, and altogether it is so light, that six people can easily transport a house of an ordinary size; and, being so small, each family is possessed of a number proportioned to its wants. A bulrush palisadoe eight feet high, bound together in the same manner as the sides of the houses, surrounds the whole. Within this inclosure, the goats, sheep, and hogs, &c. are always kept during the night: the entrance is secured by a door of similar materials to the palisadoe. Simple as the inclosure is, it would appear from the natives having no other, that it completely answers their purpose; although from an adventure which befel Captain R. Norris of Liverpool, in his factory at Whidah, (where all the trade is carried on in factories,) we may conclude, that the Congoese owe their nocturnal safety more to the wild beasts being well fed in the woods, than to the bulrush screens.

In the kingdoms of Whidah, Dahomy, and Benin, the houses and family inclosures are built of clay or mud, within which, the inhabitants, with their herds and flocks, are protected during the night. Captain Norris being awakened one night by an unusual noise, looked out, and discovered that it was caused by a large panther endeavouring to leap the outer wall, with a milch-goat in its mouth. The goat was brought from the ship to supply him with milk, and having heard it bleating, the panther had scaled the wall, and was now in the act of returning with his prey. Although the wall was fourteen feet high, the panther almost succeeded in clearing it the three first attempts, getting his fore feet upon the copping each time, but the weight of the goat always brought him down; after this, every succeeding attempt falling shorter of the mark, he might have abandoned his prey and regained his liberty, had not Captain Norris, hoping to save the goat, shot him. He was obliged, however, with the assistance of his black servant, who was the only other person at the time in the factory, to bury him in the yard before morning; for, if it had come to the King of Dahomy's ears, his voyage would have been ruined, Whidah being a conquered province of Dahomy; and the panther and the snake, the King's fitishes.

VILLAGES.—No detached dwellings are to be seen here as in Europe. Mutual safety obliges the inhabitants to live in villages and towns. Each village is the property of some chief, who exercises uncontrolled authority over all its members. These may be divided into two classes, the slaves and dependant relations of the Chief, both so entirely devoted to his service, as almost to realise our idea of a clan. There are a few instances where rich traders have villages of their own, consisting of two or three hundred families, but they are much exposed to the avarice and cupidity of the Chiefs, whose favour they are frequently obliged to purchase at a great price.

These possessions constitute the power and wealth of the Chiefs, who can at any time call out the male population to vindicate their rights, real or imaginary. The slaves, who comprise a large proportion of the population of this part of Africa, are employed in various ways, according to their ability and address. They live in great indolence, and are rapidly increasing in numbers,—equally to the comfort and affluence of their masters; by whom, upon the whole, they are treated with much humanity.

CHIEFS.—Each Chief is regarded as the father of his own district, from whose judgment there lies no appeal, save only to Boonzie. Although they all acknowledge the King's sovereignty; yet a few, combining their resources, can at any time resist his authority. Indeed, there is reason to think that they seldom or never act in concert, except when threatened by an enemy; and even then, their quota of men and period of service, are liable to various contingencies,—want of arms for instance, or scarcity of provisions; either of which will render their assistance of no avail, or, rather, will make their presence a scourge. The only power capable of controlling them is the priesthood. The

Chiefs, as well as their dependants, are remarkably fond of tobacco, which, however, from the method of curing it, is very bad. European spirits are in great request among them,—even Boonzie himself is not exempt from their bewitching influence, —so, what can he say to his erring flock?

MODE OF TRAVELLING.—A Chief, when travelling, or on a visit of ceremony, affects a great deal of state, and is accompanied by a considerable number of followers. He sits in a sort of hammock borne by four men, each of whom has a grass cushion upon his head, supporting a bamboo about twelve feet long, to which the hammock is stretched. In this, the Chief sits, his legs hanging over the side, and his arms resting upon the bamboo. Twelve men are appointed to carry the hammock, which they do alternately, by fours; some, to hold an umbrella over the Chief's head, whilst others carry drums, trumpets, lyres, and the chingonga. In this manner they easily travel twenty miles a-day. When it approaches a town or village, or meets another chief and his retinue, the cavalcade quickens its pace; the different individuals form in a file behind the Chief, and the musicians exert all their energies in producing a noise, than which, to an European ear, nothing can be more inharmonious or discordant.

CONSULTATIONS.—When any affair of importance is in contemplation, the neighbouring chieftains assemble to debate upon its expediency, and, if agreed upon, to concert proper measures for carrying it into execution. Each chief is attended by a certain number of adherents, according to his rank. The conference is generally held beneath the shade of some gigantic cotton-tree, whose wide spreading branches would screen a little army. Having seated themselves in a circle, palm-wine is introduced alongst with the subject of discussion, and no doubt contributes much to their eloquence! Nor do they forget, amid the graver matters of the state, the minor, but more fascinating virtues of tobacco, to which, in all its modes, they do ample justice.

SANGA.—The conference is preceded by a war-dance, called, *[illegible]ning Sanga*; and it is a point of ambition, who in the assembly shall exhibit this with the greatest effect, yet only a small number excel in it. The dance begins by a man rushing into the midst of the circle, brandishing a sword in his right-hand;

with this he reels about in every possible direction, writhing his body into the most extraordinary attitudes. His whole countenance becomes distorted, and expressive of the strongest agitation, which, with the fixed stare of his eyes, gives him all the appearance of a maniac. This state of violent exertion having continued about three minutes, another starts up in his stead, and endeavours, if possible, to outdo him in the frantic display of violent and unnatural motions. When the dancers have thus exhibited their talents, the conference is opened. During the continuance of the Sanga, the whole group applaud each performer, and clap their hands in approbation of his skill and dexterity.

DRESS.—The ordinary dress of the men in all the countries between Cape Lopez and Benguela, is similar, and extremely simple: It consists of four or five yards of coarse European manufacture, or as many grass-cloths sewed together as may be requisite. When folded round the lower part of the body, it is fastened above the loins by a few yards of red or blue cloth tied in a large knot. This garment reaches to the middle of the leg; the upper part is turned down over the belt, and the ends meet on the left thigh, the corners touching the ground. A cat's skin, an indispensable article of dress, hangs in front: the head, by which it is suspended, is turned downwards over the knot, and at its mouth usually hang a number of hawk-bells, keys, and other trinkets. A large tobacco-pipe, a knife or dagger, and a fitish, are secured beneath the belt. These, with a bracelet of ivory or brass on each wrist, a piece of iron-chain on the ankles, and a common worsted cap lying loosely on the head, complete the dress. The latter article, however, is seldom worn by the chiefs, whose whole costume, on days of ceremony, consists of much finer materials. In addition to the other parts of their dress, they wear the grass-cap and shawl on these occasions: their legs and arms are decorated with ivory and brass bracelets, which, with a quantity of fitishes suspended from the left shoulder, make a dreadful noise. The hair, which is commonly worn short, is ingeniously shaven in a very singular manner: The head is divided, as it were, into compartments, of which, each alternate one is cut out and the other allowed to grow. This order is reversed each successive shaving, the long hair being cut, and the short, left.

WOMEN.—The Chiefs consider their wives as indispensable appendages of grandeur and dignity. The great mass of the people regard them as a source of wealth and independence. They perform every servile office, cultivate the ground, herd the sheep and goats, make baskets, spin, weave, &c., whilst the men doze away their time in smoking tobacco, or drinking palm-wine, except when engaged in war, in the chace, or in fishing, &c. The number of wives may thus be truly said to constitute the riches of the middle class.

The dress of the women differs considerably from that of the men: They have neither the cloth-belt, cap, shawl, nor cat-skin, not even a fitish to guard them from danger! They are, however, allowed the unlimited use of beads and shells; and with these they decorate their persons most profusely: a few strings of beads supply the place of the belt. There is scarcely an article of dress upon which they set a higher value than the hair of the elephant's tail. It is worn around the neck with large pieces of coral strung upon it.

Tedious as are the operations of the toilet in our own country, they are of short duration compared to that process in Congo, where a whole day is often insufficient for the completion of a single head. Over the eye-lashes, black lines are drawn, and the front teeth are filed into one or two sharp fangs. Many of the women ornament their bodies with a sort of tatooing, which, judging from the size of the scars, must be a very cruel operation; but the custom is not common: they do not stain the wounded parts in the manner of the Otaheiteans, with a colouring substance. A married woman generally wears her hair after the fashion of her husbands. Young women arrived at a certain age paint their bodies with a paste made from the powder of red-wood; and, instead of shaving their heads, although the hair is still kept short, plait it in elegant curves close to the skin.

Singing and dancing are two necessary accomplishments of a female. For these, however, and the servile offices of the conjugal life, she is chiefly valued. The wife is the property of her husband; who, for certain misdemeanours, can sell her; but his expedient is seldom resorted to, especially if her father be a man of consequence; in that case, recourse is had to the ordeal trial. She is in a manner purchased from her relations, than whose consent, no other sanction is requisite to constitute the marriage. Their approbation is expressed by acceptance of a present, generally adequate to her full value were she sold in the market.

DANCING.—No opportunity is lost of engaging in this favourite amusement: In good weather, every village sends forth its evening band of joyful dancers. The circle being formed, a couple step forward and commence the dance, which is carried on with much animation; and having exhausted all their agility and address, they are relieved by another pair who advance from opposite parts of the circle, and this is continued in succession, until the whole group is completely wearied. Their various movements and attitudes, grotesque and uncouth as they are, harmonize with the wild and plaintive measure of the song. A full chorus, accompanied by the notes of a rude five-stringed lyre, produces a very pleasing effect.

SLAVES.—When a ship arrives after a long interval of trade, six weeks generally elapse before the slaves come down to the coast. The brokers have to notify her arrival to their respective bushmen or inland traders, who reside at the great slave mart in the interior of the country; and to whom they must send suitable presents previous to any negociation. By all accounts, the slaves are so reconciled to their unhappy lot, that they evince very little concern at the final separation from their friends and country; but this, without any want of natural affection, may be the consequence of living continually under the apprehension of such an event;—nor do the friends on their part testify a greater degree of sorrow: this, perhaps, partly arises from a consideration of individual safety to themselves, conjoined with causes unknown to us. We do not hear that the wretched victims are feelingly alive to their lamentable situation; but let us recollect, that fortitude and contempt of suffering, are among the greatest virtues of the savage mind.

STATURE.—The inhabitants of these countries are of the middle stature, and may be reckoned the blackest, as well as the most handsome, of the Negro race. To a full chest, and well-proportioned limbs, we find united, regular features and an expressive countenance.

Character.—They have been called a jealous, cruel, and revengeful people,—much given to theft; but, in my opinion, very unjustly. I would rather term them, in their ordinary mode of life, a mild, inoffensive, and effeminate race; yet of astonishing resolution and perseverance when once roused to action. Of all the slaves brought from the coast of Africa, those of Congo are accounted the most refractory and determined on ship-board.

As an instance of their probity and honour;—Captain Coufflin, when sailing up the river, run his ship upon a sunk rock. He was obliged to unload the whole cargo whilst the vessel was refitting; and, although the goods remained in their huts all that time, not a single article was missing.

To the spontaneous productions of nature, and to the climate which causes them to spring up so luxuriantly and in such profusion, must be ascribed the effeminacy of the Congoese, not to any inherent defect in the constitution of a race, whose outward appearance, time and situation have so altered. The Negro, in his native land, is, comparatively speaking, in a great measure exempt from toil; he enjoys life to the full, and, by a little tuition, can think as acutely and act as justly as the man, who, born in a civilised country, has enjoyed all the advantages of education.

Art. III.—*Account of Electro-Magnetic Experiments made by* MM. Van Beek, Professor Van Rees *of Liege, and* Professor Moll *of Utrecht.* In a Letter to Dr Brewster.

My Dear Sir,

I had the honour of addressing to you the details of some Electro-magnetic experiments in a former letter, which I hope came duly to hand. I have since observed in the Annals of Philosophy for August 1821, a letter from Sir Humphry Davy to Dr Wollaston, in which experiments are related, which you will have found to be of the same kind as those which were communicated by me. As Sir Humphry states his experiments to have been made in October 1820, no doubt can arise respecting their ha-

Fig. 1

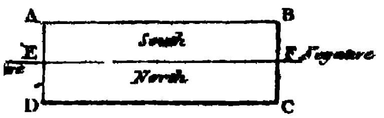


Fig .

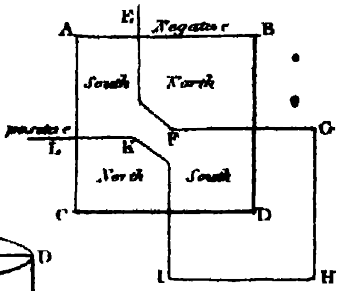


Fig 5

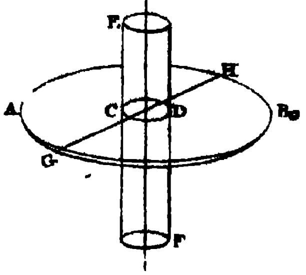


Fig 3

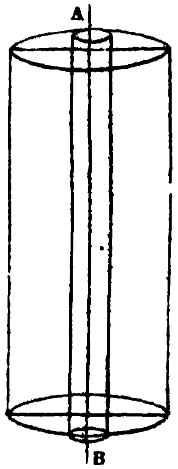


Fig 4.

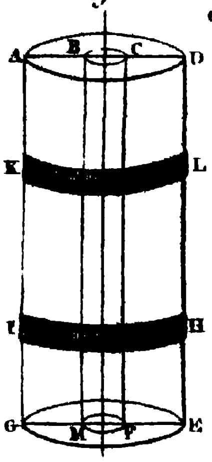


Fig 6

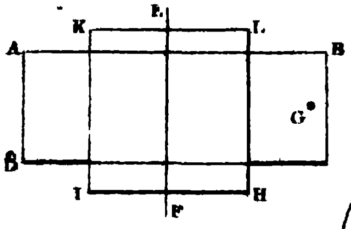


Fig 8

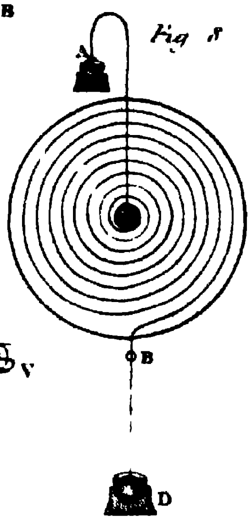


Fig 7

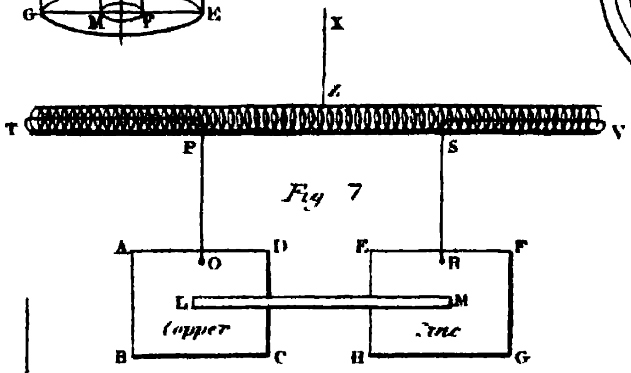


Fig 11

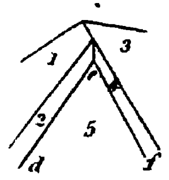


Fig 12

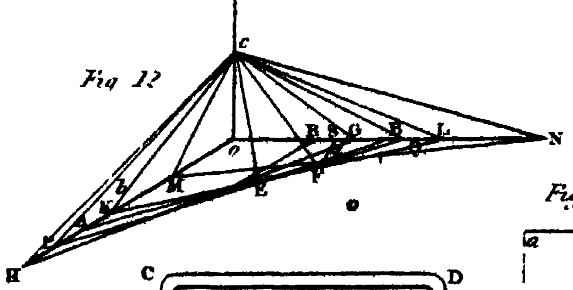


Fig 13

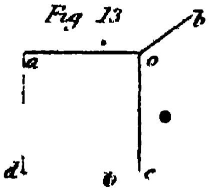


Fig 10

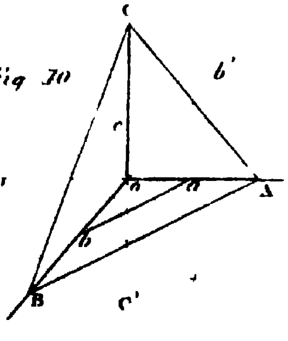


Fig 9

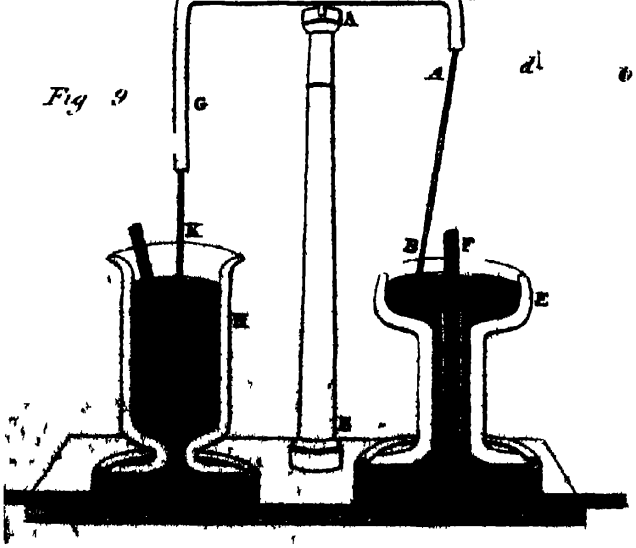
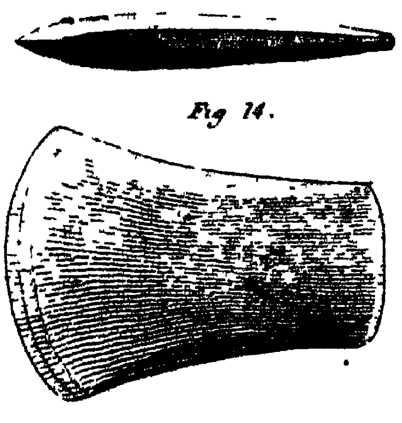


Fig 14.



ving been previous to ours, though, I can assure you, that we received the number of the Journal in which they are communicated after my letter to you had been sent off. Be this as it may, we cannot help feeling pleased with having been employed in making experiments on a subject which attracted the notice of so illustrious a philosopher as Sir Humphry Davy.

I shall now proceed to relate some further experiments; but as I keep no minutes of my letters, it is not impossible that some of those which I am going to state are already contained in my former communication.

1. Having taken a steel-plate ABCD, Fig. 1. Plate II., we laid on it a glass-pane, and on the glass was placed a communicating brass-wire E; through this the Leyden battery was discharged; the end E of the wire communicating with the interior coating, the end F with the exterior coating of the battery. The steel-plate became magnetic by the discharges; the whole of the part ABFE having acquired a north, and the part FCDE a south pole.

2. We took a square plate of steel ABCD, Fig. 2.; on this, as usual, was laid a glass-plate, and on this a connecting brass-wire, bent as shewn at EFGHIKL. Through this wire the electric discharge of the battery was transmitted, and the steel-plate became magnetic, as shewn in the diagram. The end L of the wire communicating with the interior, the end F with the exterior coating of the battery, the parts BF and KC of the plate had north, the parts AF and FD had south, magnetic polarity.

3. We took a steel-cylinder, Fig. 3. of about an inch in diameter, and three inches long, perforated through its axis AB. Through this aperture was thrust a glass-tube, open at both ends, in which a brass communicating-wire was placed. Repeated powerful electric discharges gave no magnetism whatever to the cylinder.

4. We had a steel-cylinder, Fig. 4., made of two halves, kept together by two brass-rings, and perforated in the same manner as that described in the former experiment. When the brass-rings KL and IH are taken off, the cylinder separates into two halves ABMG and CDEF. Through the axis of the cylinder, whilst kept together by the rings, strong discharges were passed, and the cylinder, as in the former experiment, shew-

ed no magnetism; but when taken asunder, both halves were found magnetic, each having an opposite pole to the other. On joining them again, all magnetism disappeared, but on separating them, it shewed itself again.

5. We took a steel-disk, Fig. 5., of about one inch in diameter, perforated in its centre, in which was placed a glass-tube, containing the wire through which the electric-battery was repeatedly discharged. AB is the steel circular disk; and CD the hole in its centre, through which is stuck the glass-tube, EF. The strongest discharges could not make this disk show any magnetism; but when it was cut with a chisel in the direction of any of its diameters, for instance GH, both halves became magnetic, each having a pole opposite to the other. Thus, GAH was the north, and HBG the south pole. When again joined together, no polarity appeared.

6. As it might be suspected that the cutting of the disk with the chisel made it magnetic, another disk was cut through, without passing the electric discharge along its axis. It was not, however, found to be magnetic.

7. Over a slip of brass ABCD, Fig. 6., was laid a glass-plate KLHI. Over the glass, the communicating-wire EF of the electric-battery went across. In the brass was a small hole G; and in this a steel-needle, not magnetic, was stuck perpendicularly. After passing the discharge through EF, it became strongly magnetic.

8. I shall now proceed to describe two very convenient electro-magnetic apparatuses, made by my ingenious friend M. Van den Boss. They are intended to show magnetism to be communicated to wires through which a galvanic current is circulating. ABCD, Fig. 7. is a copper, and EFGH a zinc, square plate, of about three centimeters side, kept from touching each other by the interposition of some small piece of wood LM. Both plates are attached and suspended to slender brass-wires, OP and RS. The wire OP enters at P, in the hollow space formed by a case of very thin quills inserted together, and two decimeters long. The end of the wire comes out of the quill at the end T, and returns, being wound as a spiral round it externally to the other end V, where it again enters the quill, and proceeds by a right line to S, where coming out, it descends, and is attached to the

other plate. The whole is suspended in equilibrium to some silken untwisted thread XZ. It may be observed, that the distance P S, ought not to be so large as drawn in the figure, and care should be taken to prevent the spiral twisted round the quill-tube from touching the wires P and S. The plates are now dipped in dilute acid, and the whole is suspended at X. Now, if a strong magnet is brought near T or X, it will show a strong polarity, by its attraction or repulsion. Thus, the apparatus, with no other galvanic-battery but the two small plates, shows the same phenomenon for which M. Ampere uses the instrument represented in Plate ii. Fig. 3.[*] of that gentleman's paper on electro-magnetism, and which requires a pretty strong galvanic force.

Another instrument delineated by M. Ampere, Fig. 2. Plate iii.[†] may be more easily constructed thus: A brass-wire AC, Fig. 8. rests at its bent end A in a cup containing some mercury, and is very moveable in azimuth round this point. The other end C, passes through the centre of a circular piece of thin pasteboard, and then forms spiral turnings round this circular piece. The wire is attached by linen or any thread to the disk, the diameter of which, in my instrument, is about eight decimeters, there being about fourteen windings of the spiral. To its end B is suspended another wire, whose end reaches again the surface of the mercury in the small cup D. The wires of the two poles of a galvanic-battery are in contact with the mercury in the cups A and D. It is required that the end of the wire A, on which the apparatus rests, should have a very free motion on a point placed in the middle. The plane of the disk will place itself in a situation perpendicular to the magnetic meridian, when the cups A and D communicate with the opposite poles of the battery.

I received, some days since, the apparatus lately contrived in England by Mr Faraday, of which I have not yet found a description in any of the Scientific Journals, but which I expect to find in your next number. This little apparatus works to admiration. No other shows so clearly the magnetism of the connecting wire. For if a strong magnet is brought near the end of the pendulum-wire AB, Fig 9. it is strongly attracted *. Believe me, Dear Sir, very sincerely yours, G. MOLL.

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[*] See this *Journal*, Vol. IV., Plate VIII. Fig. 3.

[†] See this *Journal*, Vol. IV., Plate VIII. Fig. 7.

UTRECHT, 8*th December* 1821.

ART. IV.—*Barometrical Observations made at the Fall of the Staubbach, by* J. F. W. HERSCHEL, Esq. F. R. S. L. & E., and CHARLES BABBAGE, Esq. F. R. S. L. & E. In a Letter from Mr BABBAGE to Dr BREWSTER.

MY DEAR SIR,

I PROMISED a short time since to send you an account of some barometrical observations made by Mr Herschel and myself at the Fall of the Staubbach, during last summer. There are some circumstances attending the observations at the foot of the great fall, which seem worthy the investigation of other travellers who may visit the magnificent valley of Lauterbrunnen, and who may have more time than we had for the inquiry.

The finest view of this beautiful cataract, is that which presents itself to the traveller on descending the Wenger Alp, on his way from Grindelwald and Lauterbrunnen, as it is there only that the upper fall becomes visible.

I have assumed the ground-floor of the inn where we were accommodated, as the point to which all the measurements are referred. There are several reasons for this, amongst which may be mentioned, that I had previously determined very accurately its height above the stream which passes through the valley, and that the observations I made at the inn were not completed until the instrument had in both cases been exposed to the atmosphere a full hour.

We left the inn a few minutes after seven in the morning, and following a circuitous path, arrived in little more than an hour at a small wooden bridge, which traverses the torrent at some distance above the upper fall. It descends from this spot with great rapidity; and finding it inconvenient to follow its bank, we arrived, by a little circuit, at the foot of the upper fall. The water descends from a projecting ledge in a wide sheet; and it appeared that a traveller might, in any season, walk between the fall and the rock, without being wetted by its waters. We now followed the bank, and in a short time, by a very steep descent, reached the top of the great fall. On the left side, looking down the stream projects a rock, over one part of which the torrent precipitates itself. From this spot, the valley, and the trees at the foot of the fall, are visible; but that point where the water reaches the ground cannot be seen. The stream had worn a channel in the limestone rock for some distance above the fall; and after being precipitated over the edge, at about forty feet below, strikes very obliquely against a rock on the left side. This gives it an inclination in its downward course, which makes it appear to be slightly convex towards the upper part of the valley, unless there is a current of air along it, or other causes intervene to prevent it. The following are the observations from which the heights were deduced:

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* As this ingenious apparatus was described in our last Number, viz. Vol. VI., p. 178., without a reference to a figure, it may be sufficient to state, that in Fig. 9. AB is the brass pillar; CD the copper-rod; E the shallow glass-cup with mercury; F the magnet; G the descending rod of metal; H the cylindrical cup; I the second bar magnet; and K the thick wire descending from the rod above. See the *Quarterly Journal*, vol. XII. p. 28.

STATION.	Hour of Day.	Barometer.	Attached Therm.	Detached Therm.	No. of Obs.
	h ′	Inches.	Fahren.	Reaum.	
Inn at Lauterbrunnen,	7 10 A.M.	27.182	55°.2	9°.2	1
Staubbach Bridge, -	8 30	25.7675	61	10.1	2
Foot of Upper Fall, -	9 15	26.026	59.5	10.1	1
Top of the Great Fall,	9 30	26.1402	55.3	10.8	3
Inn at Lauterbrunnen,	11 7	27.186	56.3	10.8	1
Foot of the Great Fall,	12 20	27.1137	57.8	11.8	4

The two observations made at the inn have been reduced and interpolated in the table below:

Hour of Day.	Barometer.	Attached Thermom.	Detached Thermom.
h ′	Inches.	Fahrenheit.	Centigrade.
7 10 A. M.	27.1851	56°.3	11°.50
8 30	27.1854	do.	12.38
9 15	27.1856	do.	12.75
9 30	27.1856	do.	12.88
11 7	27.1860	do.	13.88
12 20	27.1863	do.	14.63

From these I have deduced, by calculating the observations according to M. Ramond's method, the following heights:

	Feet.
Bridge over the Staubbach, above the Inn at Lauterbrunnen,	1485.7
Foot of Upper Fall above Inn, - - -	1210.4
Top of the Great Fall above Inn, - - -	1078.5
Foot of Great Fall above Inn, - - -	78.4
Height of Great Fall, - - - -	1000.1

Mr Herschel, using almost the same data, and calculating by the tables of Oltmanus, has arrived at results nearly coincident with these.

The stations where we placed the barometer are easily found, except that at the foot of the great fall, which I will now describe more particularly.

As you approach it by a path at the side of the stream which flows from it, the lower part of the fall appears partly hid by a heap of debris, consisting of small stones brought down by the torrent. The little hill which is thus formed, is almost barren, and inclosed by wooden palings. We chose a situation where the eye was nearly on a level with the spot where the water reaches the ground; and looking for a spot on the hillock, as far as we could from the spray of the fall, and on the same level, we noticed a few shrubs, and at that spot placed our barometer. As you cross the railings, it is on the right hand, very near them, and at the beginning of the few shrubs that grow there. Although the atmosphere, both in the valley and on the mountain, was perfectly calm, in the neighbourhood of the bottom of the fall there was a strong but irregular current. We made four observations, and as they differ considerably, we took the means. They are as follows:

No.	Barometer.	Attached Thermom.	Detached Thermom.	
	Inches.	Fahrenheit.	Reamur.	
1	27.126	58°	11°.8	B b
2	27.106	57.9	do.	B h
3	27.113	57.8	do.	B b
4	27.110	57.8	do.	B h
	27.11375			

The first of these differs so much from the mean, that it ought to be rejected as a bad observation; and I should have omitted it, if the others had been more accordant amongst each other;

but I made it with much care, and was a considerable time before I satisfied myself of the adjustments of the two levels. Mr Herschel was in the mean time taking the temperature of the water, which he found to be the same as that of the air; whilst at the point where it quits the summit, it was between two and three degrees of Reaumur colder. I now held my handkerchief to protect the instrument from the wind and mist produced by the fall, whilst my friend made an observation. This is No. 2. Finding it so very different from mine, I again made one with considerable care, No. 3. and then Mr Herschel made No. 4. Amongst some hundred observations, I have not met with instances of our differences amounting to half or even a quarter of that which occurs here; and from the care with which the observations were made, I conclude some cause of irregularity operated, of which we were not aware. There are two circumstances which seem to have some influence on these results: one is the state of the atmosphere at the foot of the fall, and as high as a thousand feet above it, being in a state of saturation with regard to moisture; the other is the violence of the wind which is formed by the descending torrent, and which eddies about with rapidity in all directions. Notwithstanding the differences in the observations, I am inclined to believe the mean to be extremely near the truth. At the bottom of a meadow immediately below the inn, there is a small stream, and a fish-box at its junction with the river which waters the valley of Lauterbrunnen. The ground-floor of the inn is 114.6 feet above this spot. I remain, my Dear Sir, truly yours,

C. BABBAGE.

DEVONSHIRE STREET,
PORTLAND PLACE,
Dec. 7. 1821.

ART. V.—*On the Determination of certain Secondary Faces in Crystals, which require neither Measurement nor Calculation.* By A. LEVY, M. A. of the University of Paris. Communicated by the Author.

THE observation of the several polyhedrons, or crystals presented by the same crystallised substance, naturally leads us to inquire, whether there is any relation between these different forms. Many remarkable results have been obtained by the investigation of this question. These results, together with the necessary methods for verifying their exactness, and resolving the problems to which they give rise, compose the science of crystallography.

The two principal facts hitherto ascertained, are,

1*st*, That for a given series of polyedral forms belonging to the same substance, a simple solid can always be assigned, from which all the others may easily be derived, by the replacement of its edges and angles. This solid is called the Primitive form of the substance. The others are called Secondary. The faces of the primitive are called primitive faces; those of the secondary crystals secondary faces. Two edges of the primitive are said to be similar, when they are of equal length, and intersections of planes equally inclined. Two plane angles of the primitive are similar, when they are equal, and formed by similar edges. The primitive form is generally found among the crystals offered by the substance, and when put in a proper position, relatively to any secondary crystal, all its faces, or at least some of them, are found to be parallel to the direction of the cleavage of that secondary crystal.

The mode in which the secondary forms are derived from the primitive is this: Let oa, ob, oc, Plate II. Fig. 10. be the directions and lengths of three of the edges of the primitive, meeting at a solid angle o. Then any secondary crystal may be so placed, relatively to these three lines, that any one of its faces is found to be parallel to such plane as ABC meeting the lines oa, ob, oc, in A, B, C, whose distances to o, oA, oB, oC, are found respectively to be very simple multiples, m, n, P, of oa, ob, oc; or two of them being very simple multiples, the third is infinite.

If the plane ABC was drawn parallel to a secondary face, replacing neither the angle o, nor any of the edges meeting in o, but some other angle or edge of the primitive, this plane might meet one or two of the lines oa, ob, oc in some point of their producement, oa', ob', oc'; but the distances of those points to o, would still be simple multiples of oa, ob, oc. From this mode of derivation, it results, that in secondary crystals, the derivations alone of the faces are considered, and that two identical secondary forms are neither two equal or two similar polyedrons, but two solids composed of the same number of faces, and such that when both are put in position with the primitive, all the faces of the one are parallel to all the faces of the other. Upon this first result of crystallographical researches, M. Haüy has built his theory of decrements, supported by so many facts, and so much ingenuity. It is well known, that in that theory, a secondary face, such as ABC, Plate VIII. Fig. 10. is said to be the result of an intermediary decrement upon the angle *o* of the primitive, by *m* rows parallel to the edge *oa*, *n* rows parallel to the edges *ob*, and *p* rows parallel to the edge *oc*. If $m = n$, then AB is parallel to the diagonal *ab* of the face *oab* of the primitive, and the face ABC is then the result of a decrement upon the plane angle *oab*, by *m* rows in breadth, and *p* in height. Lastly, if *p* is infinite, then ABC becomes parallel to the edge *oc*, and is said to be the result of a decrement upon that edge by *m* rows in breadth and *n* in height. It will be more simple in what follows, to call *m*, *n*, *p* the indices of the face ABC.

The second important result of Crystallography, is what has been called the Law of Symmetry. It consists in this, that, with very few exceptions, when any edge or angle of the primitive is found to be replaced by a secondary face resulting from a certain decrement, all the similar edges or angles are equally replaced by faces resulting from similar decrements.

This once understood, all questions of crystallography may be reduced to problems of solid geometry, and may be resolved by plane and spherical trigonometry. The data are the incidences of the secondary faces with each other and with the primitive; the unknown quantities, the linear dimensions of the primitive, and the indices of the secondary faces.

To shew in each case how to obtain as many equations as there are unknown quantities, or, when this is impossible, to point out the best hypothesis that can be made to replace the want of equations, will be the object of another paper, which I shall publish, when I have brought my formulæ to that degree of simplicity which logarithmic calculation requires.

My object here, is to explain how the indices of certain secondary faces can be obtained without either measurement or calculation.

Although there are three indices, m, n, p, for each secondary face, the number of unknown quantities is really only two, $\frac{m}{p}$, and $\frac{n}{p}$. Two conditions are therefore sufficient and necessary to determine them. These conditions are generally the incidences of the face upon two known planes of the crystal; and when they are such, calculation alone can determine the law of decrement. But in numerous cases, the observation of the face to be determined, having two of its sides parallel to two edges of the crystal, whose positions relative to the primitive are known, will be sufficient to resolve the problem, without the assistance of either goniometer or trigonometry. Thus, in Fig. 11. which represents a portion of a crystal, the indices of the planes 1, 2, 3, 4, being known, those of the plane 5 may be obtained, from the circumstance of its two sides *ed*, *cf* being parallel to the intersection of 1 and 2, and that of 3 and 4. Before explaining how this can be done, it is proper to remark, that these parallelisms are, in most cases, easily ascertained by the eye alone, from the narrowness of the planes bounded by the parallels. The disproportion of the faces of the crystal often facilitates this kind of observation. Besides, when the planes of the crystal are sufficiently brilliant, the reflecting goniometer will readily decide if the parallelism does exist or not, and even discover those that the eye could not suspect. For it is obvious, that when the crystal is so adjusted, as to give horizontally the reflections of an horizontal line upon two different planes of the crystal, any third plane, upon which the reflection of the same line would still be horizontal, must be parallel to the intersection of the two first. Hence, when the reflecting goniometer is used, after having adjusted two faces of a crystal, it will be of importance to turn it completely round, in order to ascertain if there is any other face parallel to the intersection of the two first.

Now, to resolve the proposed problem: Let m_5, n_5, p_5, be the indices of the plane 5, relative to three edges, *oa*, *ob*, *oc*, Fig. 10. of the primitive; m_4, n_4, p_4, those of the plane 4, and so on. What is to be done, is to find the values of m_5, n_5, p_5, when all the others are known. Let *oa*, *ob*, *oc*, be taken for three axes, co-ordinates, and x, y, z represent the co-ordinates of any point parallel to them. Then *a*, *b*, *c* being, as before, the lengths of the three edges *oa*, *ob*, *oc*, the equation of the plane 5, will be,

$$\frac{x}{m_5\, a} + \frac{y}{n_5\, b} + \frac{z}{p_5\, c} = 1.$$

since that plane cuts the three axes, at distances from *o*, equal to $m_5\, a$, $n_5\, b$, $p_5\, c$. In the same manner the equations of the four planes, 1, 2, 3, 4, will be respectively,

$$\frac{x}{m_1\, a} + \frac{y}{n_1\, b} + \frac{z}{p_1\, c} = 1.$$

$$\frac{x}{m_2\, a} + \frac{y}{n_2 b} + \frac{z}{p_2\, c} = 1.$$

$$\frac{x}{m_3\, a} + \frac{y}{n_3\, b} + \frac{z}{p_3\, c} = 1.$$

$$\frac{x}{m_4\, a} + \frac{y}{n_4\, b} + \frac{z}{p_4\, c} = 1.$$

To express that the intersection of 1 and 5 is parallel to that of 1 and 2, it is sufficient to write that their projections upon a third plane are parallel; since those two lines are in the same plane 1. By eliminating z between the two first equations, the equation of the projection of the intersection of 1 and 2 upon the plane *oab* is obtained;

$$x\left\{\frac{1}{m_1 p_2 a} - \frac{1}{m_2 p_1 a}\right\} + y\left\{\frac{1}{n_1 p_2 b} - \frac{1}{n_2 p_1 b}\right\} = \frac{1}{p_2} - \frac{1}{p_1}.$$

In the same manner, the equation of the projection of the line of intersection of 1, and 5, is,

$$x\left\{\frac{1}{m_1 p_5 a} - \frac{1}{m_5 p_1 a}\right\} + y\left\{\frac{1}{n_1 p_5 b} - \frac{1}{n_5 p_1 b}\right\} = \frac{1}{p_5} - \frac{1}{p_1}.$$

These equations being those of parallel lines, the ratio of the coefficients of x and y in the first, must be equal to the ratio of the coefficients of x and y in the second. This, after reduction, gives,

$$p_2(m_1 n_2 - m_2 n_1) = m_1 m_2 (p_1 n_2 - n_1 p_2)\frac{p_5}{m_5} - n_1 n_2 (p_1 m_2 - m_1 p_2)\frac{p_5}{n_5}.$$

By changing in this equation m_1, n_1, p_1 into m_3, n_3 p_3, and m_2, n_2, p_2, into m_4, n_4, p_4, we shall get the equation expressing the parallelism between the line of intersection of 5 and 3, and that of 3 and 4. From these two equations, the values of $\frac{p_5}{m_5}$ and $\frac{p_5}{n_5}$ are readily found.

$$\frac{p_5}{m_5}=\frac{\left(\frac{1}{p_1 m_2}-\frac{1}{p_2 m_1}\right)\left(\frac{1}{n_3 m_4}-\frac{1}{m_3 n_4}\right)+\left(\frac{1}{n_1 m_2}-\frac{1}{n_2 m_1}\right)\left(\frac{1}{m_3 p_4}-\frac{1}{m_4 p_3}\right)}{\left(\frac{1}{p_1 m_2}-\frac{1}{p_2 m_1}\right)\left(\frac{1}{n_3 p_4}-\frac{1}{p_3 n_4}\right)+\left(\frac{1}{n_1 p_2}-\frac{1}{n_2 p_1}\right)\left(\frac{1}{m_3 p_1}-\frac{1}{m_4 p_3}\right)}$$

By writing in this formula m for n, and reciprocally, the value of $\frac{p_5}{n_5}$ is obtained.

If the two faces 1 and 2 are supposed to be parallel to a diagonal of the primitive—to *ab*, for instance, then the new face 5 will be parallel to the same diagonal. In that case, $m_1 = n_1$, and $m_2 = n_2$, the values of $\frac{p_5}{m_5}$ and $\frac{p_5}{n_5}$ become both the same, and, by reduction, equal to

$$\frac{\frac{1}{(n_3 m_4 - m_3 n_4)}}{\left(\frac{1}{n_3 p_4}-\frac{1}{p_3 n_4}\right)+\left(\frac{1}{m_3 p_4}-\frac{1}{p_3 m_4}\right)}$$

m_1, n_1, p_1; m_2, n_2, p_2, have entirely disappeared from this formula; and it should be so, since the condition of being parallel to a diagonal of the primitive, does not depend upon any secondary plane. If the two faces 1 and 2 are parallel to an edge, to *oc*, for instance, then 5 is parallel to the same; p_1 and p_2 are infinite. The values of $\frac{p_5}{m_5}$ and $\frac{p_5}{n_5}$ become so too, when the infinite is substituted for p_1 and p_2 in the general formula. But if, before making the substitution, we divide the one value by the other, we then get

$$\frac{m_5}{n_5}=\frac{\frac{1}{n_3 p_4}-\frac{1}{p_3 n_4}}{\frac{1}{m_3 p_4}-\frac{1}{m_4 p_3}}.$$

These three formulæ, the first principally, are not very simple; but it must be observed, that the problem has been resolved in the greatest degree of generality. In most cases that occur, they will be considerably simplified, and frequently dispensed with. They might have been obtained in a very different way, by a series of similar triangles. The preceding method has been thought more simple and more direct. However, as the other may be used with advantage in some cases, it will not perhaps be useless briefly to indicate it.

By the extremity *c* of the edge *oc* of the primitive, Fig. 12., let the planes *c*HG, *c*KL, *c*MN, *c*PQ, be drawn parallel to 1, 2, 3, 4, the distances *o*H, *o*G, &c. will be known, and equal to $\frac{n_1}{p_1}b$, $\frac{m_1}{p_1}a$, &c. The intersection of 1 and 2 will be parallel to *o*E, that of 3 and 4 to *o*F. The new plane 5 will therefore be parallel to the plane *o*EF; and if the line EF is drawn, *o*A will be equal to $\frac{n_5}{p_6}$, and *o*B to $\frac{m_5}{p_6}$. Now, to find the values of these, let ER, F*s*, be drawn parallel to *ob*. It is very obvious, that knowing *o*G, *o*H, *o*K, *o*L, the values of ER, *o*R may easily be found by similar triangles. Those of F*s* and *os* are not more difficult to obtain, and from these four, *o*R, RE, *os*, *s*F, the values of *o*A and *o*B are easily deduced. This would lead to the same formula.

These formulæ, although they are complicated, are remarkable. They contain neither *a*, nor *b*, nor *c*. Therefore, the linear dimensions of the primitive form are not requisite to determine the laws of decrements of the faces under consideration. This remark proves, also, that it is not possible to find the values of the linear dimensions of the primitive, from any observation of parallelism between the edges of a secondary crystal. The values of m_1, n_1, p_1, &c. being simple numbers, it is obvious, from the nature of the functions of them, which represent the values of m_5, n_5, p_5, that the values of these last quantities will never be very large numbers. It is necessary to add, that when these formulæ are used, m_1, for instance, must be taken negatively, if the face whose indices are m_1, n_1, p_1, cuts the edge *oa*, Fig. 10., in its prolongation *oa*′. The same observation applies to any other index.

To shew at once the importance and use of what precedes, I shall apply it to the determination of the several modifications of the Red Oxide of Copper and the Oxide of Tin, which Mr Phillips has given in the 1st and 2d volumes of the Transactions of the Geological Society.

Mr Phillips, in his paper on the Red Oxide of Copper, has described six modifications of that substance, the incidences of the planes of which he could not measure. Out of these six, five may, however, be determined without knowing any angle, supposing the parallelisms which exist in Mr Phillips' drawings to be correct.

For this investigation, it will be more simple to consider the cube, instead of the octohedron, as the primitive form of the substance. Once the indices relative to the cube are known, those relative to the octohedron may be obtained without difficulty.

Let *oa*, *ob*, *oc*, Fig. 13., be the edges of the cube, to which all the secondary faces are to be referred.

It is evident, *first*, That the faces of the octohedron result from a decrement by one row upon the angles of the cube, and, consequently, that the three indices of that face which replaces the angle *o*, will be equal to each other.

Second Modification.—The planes of this modification being those of the rhomboidal dodecahedron, result obviously from a decrement by one row upon the edges of the cube; so that, of the three indices relative to any one of them replacing one of the edges *oa*, *ob*, *oc*, one will be infinite, and the other two equal.

Fifth Modification.—The Fig. 81. (Plates to the 1st vol. of the Trans. of the Geol. Society), shews that one plane of this modification is parallel to the diagonal *ac*, Fig. 13., and to the intersection of the two planes of the second modification which replace the edges *oa*, *oc*. The new face being parallel to a diagonal, the second of the preceding formulæ must be used. In the present case, $m_3 = 1$, $n_3 = 1$, $p_3 = \infty$, $m_4 = \infty$, $n_4 = 1$, $p_4 = 1$. These substitutions being made, the value of $\frac{p_5}{n_5}$ is found to be equal to 2. Therefore, the fifth modification results from a decrement by two rows in breadth upon the angles of the cube.

Third Modification.—The planes of this modification are evidently parallel to the edges of the cube, and one of them is also, by Fig. 107. parallel to the intersection of the two planes of the fifth modification, replacing the angles *aoc*, *ocd*, Fig. 4. Here the third formula must be used, and the following values substituted in it.

$$m_3 = 2 \ p_3 = 2 \ n_5 = 1.$$
$$m_4 = 2 \ p_4 = 2 \ n_4 = 1.$$
$$\text{Then, } \frac{m_5}{n_5} = 2.$$

Therefore, the third modification is the result of a decrement by two rows in breadth on the edges of the cube.

Sixth Modification.—Fig. 107. shews that one plane of this modification is parallel to the intersection of the plane of the fifth parallel to the diagonal *ac*, and the plane of the second modification which replaces the edge *oc*, and also to the line of intersection of the face of the octohedron which replaces the angle *o*, and the plane of the third which replaces the edge *oc*. Therefore, here

$$m_1 = 2 \ p_1 = 2 \ n_1 = 1.$$
$$m_2 = 1 \ n_2 = 1 \ p_2 = \infty.$$
$$m_3 = 1 \ n_3 = 1 \ p_3 = 1.$$
$$m_4 = 2 \ n_4 = 1 \ p_1 = \infty.$$

These values being put in the first formula, give $\frac{p_5}{m_5} = 2$, the same values when substituted in $\frac{p_5}{n_5}$, give $\frac{p_5}{n_5} = 3$. Therefore, $p^5 : m^5 : n^5 :: 6 : 3 : 2$. The planes of the sixth modification may be consequently considered as the result of an intermediary decrement by six rows parallel to *oc*, three parallel to *oa*, and two parallel to *ob*.

As to the fourth modification, there are not sufficient data to determine it, no other parallelism being observable than those of the planes of this modification with the edges of the octohedron. The indices of the five others being now known, nothing is easier than to calculate the incidence of any two of their planes.

I shall now examine Mr Phillips' paper on the Oxide of Tin. Its merit is so well known, that I think it almost useless to say, that the remarks I am going to make upon it will in no way diminish its value, which principally consists in having measured with great accuracy the incidences of the planes of most of the modifications he has described, and in having given drawings of a great many varieties, which, though inexact, are perfectly sufficient to convey an idea of the form.

Twelve different modifications are mentioned in this paper. For nine of them, the angles of one plane of each upon two different faces are given. Eight of these may be determined without knowing any angles. But first it is necessary to correct some errors in the drawings.

From the angles given, it necessarily follows, that the planes of the seventh modification should not only be parallel to the intersection of 1 and 1, as it is indicated in the figures, (see Plates 18. and 19. to the 2d volume of the Transactions of the Geol. Soc.), but also to the line of intersection of 2 and 5.

2dly, That the planes of the sixth modification parallel to the lateral edges of the prism, should also be parallel to the intersection of two corresponding planes of the seventh modification, the one belonging to the superior, the other to the inferior summit of the crystal; or otherwise, that the line of intersection of the sixth and seventh modification should be perpendicular to the lateral edge of the prism.

All the drawings in which these parallelisms do not exist, are consequently incorrect, or the faces marked with the same figure do not belong to the same modification. These parallelisms are the essential character of the sixth and seventh modification, in the same manner as it is the essential character of the 4th, 5th, 6th, to be parallel to the axis of the prism, of the face *p* to be parallel to the intersection of two adjacent planes of the second modification; and unless it is argued that it is not necessary to indicate the latter parallelisms in the drawings, I see no reason why the former should not be preserved in the representation of the crystal.

Now, nothing is easier than the determination of the modifications. For the sake of simplicity, I shall here, as in the red oxide of copper, assume an hypothetical primitive form. It will be a square prism, whose lateral faces will correspond to the first modification, and the altitude of which will be determined by supposing the faces *p* to be produced by a decrement by one row on the angles.

Then, obviously,

The second modification will be the result of a decrement by two rows in height on the edges *b* of the bases.

The third is then the base of the prism.

The fourth, from a decrement by one row on the lateral edges.

The fifth can only be determined by the incidence of one of its planes on 1. The angle given by Mr Phillips makes it the result of a decrement by three rows on the lateral edges.

From the two parallelisms mentioned before, relative to the seventh modification, and by the use of the second formula, it will be found, that this modification is the result of a decrement by five rows in breadth on the angles of the lateral faces of the prism.

The sixth modification, from the parallelisms before ascertained, will, in an analogous way, be found to result from a decrement by five rows along the lateral edges.

The faces of the ninth modification are at once parallel to an edge of the base of the primitive and to the intersection of two planes of the seventh modification, (see Plate 21.) They are therefore produced by a decrement by five rows in height on the edges of the base.

Lastly, the eleventh modification is produced on the same edges, by a decrement by one row being parallel to the line of intersection of two adjacent faces, Plate 23. There would be no difficulty now to find the indices of these modifications relative to the octohedron, and to calculate the incidences of any two planes having once measured 2 on 1.

The conclusions to be drawn from the preceding observations are, that the parallelisms which frequently exist between the edges of a crystal, are of great importance; they are a proof of the simplicity of the structure. They enable us, without measurement, to determine a secondary face, when they are observed to exist between two sides of that face and two known edges of the crystal. The measurements in that case have no other use than to try the accuracy of the goniometer, and the perfection of the crystal. When a crystal is described, these parallelisms should be carefully mentioned: in the rough drawings, they should be preserved as nearly as possible. In exact drawings, the orthographic projection should always be used.

ART. VI.—*On the Effects of Magnetism on Chronometers.* By PETER LECOUNT, Esq.[*]. In a Letter to Dr BREWSTER.

SIR,

THE following observations on Chronometers are much at your service, if you think them worthy a place in your Journal. I find by your last Number, that the subject of the iron in ships affecting Chronometers, has employed Mr Barlow's attention as well as my own, and that he attributes it to the same cause that I do, viz. a portion of fixed magnetism in the steel of the balance or its spring. For my part, I think it will not be found possible to ascertain any shiprate for chronometers, which shall correct the errors arising from this cause, from the direction and strength of the attraction of the iron in a ship undergoing such considerable changes as it does in different dips. I always considered the remedy to lie alone in the hands of the maker, who should carefully ascertain that no steel whatever in a chronometer possesses any fixed magnetic quality; and I pointed this out to a chronometer-maker in London, in November 1820, shewing him, amongst a number of balances, those which had any portion of fixed magnetism, and those which had not, &c.; but it is requisite, that, in this respect, not only the balance and its spring should be attended to, but that all the steel in the instrument should be deprived of this quality, particularly the steel-spindles of the fusee, barrel, &c., for it is to magnetic attraction, residing wholly in the machine, that I attribute the alteration which takes place in the rates of chronometers on shore in different parts of the world, and which is often very considerable. These attractions may act in several ways; if there is fixed magnetism in the balance, and variable magnetism in the spindles of the wheels, the rate may be altered by any considerable alteration in the dip, as the direction and strength of the variable magnetism will thereby become changed; the same effect may be produced, if the fixed magnetism is in the spindles of the wheels, &c. and the variable magnetism in the steel of the balance,—the balance-spring will likewise be acted on under similar circumstances. I should therefore think it absolutely necessary, that all the steel in the machine should be divested of the fixed magnetic quality;—the variable ones will have no effect on each other: this can always be done by the action of fire, and if the mechanic, in the process of hardening and tempering the steel, always carefully cools it in a direction at right angles with the dipping-needle, it will rarely be found to possess any portion of fixed magnetism, as, on the contrary, it will be found, that small steel bodies, if heated red hot, and cooled in the direction of the dipping-needle, will often acquire this quality.

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[*] Mr Lecount is already known to the public by his interesting work "On the Changeable Magnetic Properties possessed by all Iron Bodies, and the different effects produced by the same on ships' compasses, from the position of the ship's head being altered," Lond. 1820. Some account of his Observations will be found in this *Journal*, Vol. IV., p. 296., &c. and p. 436.—ED.

I am of opinion, that this fixed magnetism, if carefully excluded from the machine at first, will not be found to return from the continual motion of its parts.

A very necessary precaution with respect to the use of these instruments, is always to hang them up on board ship at a considerable distance from the compasses. I have known an excellent chronometer rendered useless for the time, by being kept within two feet of the cabin compass, and which, when removed to a different part of the cabin, performed remarkably well.

While, on this subject, I cannot help expressing my surprise, that although it has long been shewn that the true form for the teeth of machinery, which will prevent friction, is that of an arc of an epicycloid,[*] yet this has never been adopted in chronometers. I can only suppose it to arise from the difficulty of reducing such small teeth to the form of that curve. If I thought it likely that the makers of these instruments would adopt this form of the teeth, I should be happy to propose an easy method of arriving at it for the smallest wheel used in them *. I am, Sir, your obedient Servant,

His Majesty's Ship, Queen Charlotte,
PORTSMOUTH HARBOUR,
November 10. 1821,

PETER LECOUNT,
Midshipman in the Royal Navy.

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[*] A simple and practical method of giving the epicycloidal form to the teeth of small wheels, is a desideratum in Mechanics, and Mr Lecount will do a great service to watch and clock makers by communicating his method.—ED.

ART. VII.—*Extracts from Dr* HIBBERT'*s Description of the Shetland Islands.*

THE learned and valuable work from which we have made the following extracts, has been just published by Dr Hibbert, under the title of "*A Description of the Shetland Islands, comprising an Account of their Geology, Scenery, Antiquities, and Superstitions*," and will be perused with much interest by the geologist, the antiquary, and the general reader.

As our geological readers have already been made acquainted with Dr Hibbert's Mineralogical Survey of Shetland, through the medium of this Journal[*], we shall limit our extracts at present to those objects of general science which will be more interesting to another class of readers.

I. *Account of the Pursuit and Capture of a Drove of Whales.*

I had landed at Mr Leisk's of Burra Voe in Yell, when a fishing-boat arrived with the intelligence that a drove of Ca'ing Whales[†] had entered Yell Sound. Females and boys, on hearing the news, issued from the cottages in every direction, making the hills reverberate with joyful exclamations of the event. The fishermen armed themselves with a rude sort of harpoon, formed from long iron-pointed spits;—they hurried to the strand, launched their boats, and at the same time stored the bottom of them with loose stones. Thus was a large fleet of yawls soon collected from various points of the coast, which proceeded towards the entrance of the Sound. Some slight irregular ripples among the waves shewed the place where a shoal of whales were advancing. They might be seen sporting on the surface of the ocean for at least a quarter of an hour, disappearing, and rising again to blow. The main object was to drive them upon the sandy shore of Hamna Voe, and it was soon evident that, with their enemy in their rear, they were taking this direction. Most of the boats were ranged in a semicircular form, being at the distance of about 50 yards from the animals. A few skiffs, however, acted as a force of reserve, keeping at some little distance from the main body, so that they might be in readiness to intercept the whales, should they change their course. The sable herd appeared to follow certain leaders; who, it was soon feared, were inclined to take any other route than that which led to the shallows on which they might ground. Immediately the detached crews rowed with all their might, in order to drive back the fugitives, and, by means of loud cries and large stones thrown into the water, at last succeeded in causing them to resume their previous course. In this temporary diversion from the shore, the van of the boats was thrown into confusion; and it was a highly interesting scene to witness the dexterity with which the Shetlanders handled their oars, and took up a new semicircular position in rear of the whales. Again the cetacea hesitated to proceed into the inlet, and again a reserve of boats intercepted them in their attempt to escape, while a fresh line of attack was assumed by the main body of the pursuers. It was thus that the whales were at length compelled to enter the Harbour of Hamna Voe. Then did the air resound with the shouts that were set up by the boatmen, while stones were flung at the terrified animals, in order to force them upon the sandy shore of a small creek; but before this object could be effected, the whales turned several times, and were as often driven back. None of them, however, were yet struck with the harpoon; for if they were to feel themselves wounded in deep water, they would at all hazards betake themselves to the open sea. The leaders of the drove soon began to ground, emitting at the same time a faint murmuring cry, as if for relief; the sand at the bottom of the bay was disturbed, and the water was losing its transparency. The shoal of whales which followed increased, as they struck the shore, the muddiness of the bay;—they madly rolled about, irresolute from the want of leaders, uncertain of their course, and so greatly intimidated by the shouts of the boatmen, and the stones that were thrown into the water, as to be easily prevented from regaining the ocean. Crowds of natives of each sex, and of all ages, were anxiously collected on the banks of the voe, hailing with loud acclamations the approach of these visitants from the northern seas;—and then began the work of death. Two men, armed with sharp iron-spits, rushed breast-high into the water, and seizing each a fin of the nearest whale, bore him unresistingly along to the shallowest part of the shore. One of the deadly foes of this meekest of the inhabitants of the sea deliberately lifted up a fin, and beneath it plunged into the body of the animal the harpoon that he grasped, so as to reach the large vessels of the heart. A long state of insensibility followed, succeeded by the most dreadful convulsions; the victim lashed the water with his tail, and deluged the land for a considerable distance: another death-like pause ensued; throes still fainter and fainter were repeated with shorter intermissions, until at length he lay motionless on the strand. The butchers afterwards set off in a different direction, being joined by other persons assuming the same functions. Female whales, appearing, by their hasty and uncertain course, to have been wrested from their progeny, and sucklings no less anxiously in quest of those from whose breasts they had received their nutriment, were, by the relentless steel of the harpooner, severally arrested in their pursuit. Numerous whales which had received their death-wound soon lined the bay, while others at a greater distance were rolling about among the muddy and crimsoned waves, doubtful whither to flee, and appearing like oxen to wait the return of their slaughterer. Wanton boys and females, in their anxiety to take a share of the massacre, might be observed to rankle with new tortures the gaping wound that had been made, while, in their blood-thirsty exultation, they appeared to surpass those whose more immediate duty it was to expedite the direful business. At length the sun set upon a bay that seemed one sheet of blood: not a whale was allowed to escape; and the strand was strewed over with carcases of all sizes, measuring from six to twenty feet, and amounting to not fewer than eighty in number. Several of the natives then went to their homes in order to obtain a short repose; but as the twilight in this northern latitude was so bright as to give little or no token of the sun's departure, many were unremittingly intent upon securing the profit of their labour, by separating the blubber, which was of the thickness of three or four inches. It was supposed that the best of these whales would yield about a barrel of oil; and it was loosely computed that they were on an average worth from L. 2 to L. 3 Sterling a-piece, the value of the largest being as much as L. 6.

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[*] See this *Journal*, Vol. I. p. 296. and Vol. II. p. 67.

[†] The Ca'ing Whale, under the name of *Delphinus Deductor*, is figured in Captain Scoresby's work on the Arctic Regions. It seldom exceeds 22 feet in length.

The division of the profits that accrue from these whales, was, from very ancient times, regulated by strict laws, which on the introduction of feudality varied from those of Denmark. "As soon," says Mr Gifford, "as the whales are got ashore, the Bailie of the parish is advertised, who comes to the place, and takes care that none of them are embezzled; and he acquaints the Admiral thereof, who forthwith goes there, and holds a Court, where the Fiscal presents a petition, narrating the number of whales, how and where drove ashore; and that the Judge thereof may give judgment thereupon, according to law and the country practice. Whereupon the Admiral ordains the whales driven on shore to be divided into three equal parts; one of the parts to belong to the Admiral, one part to the salvers, and one-third to the proprietor of the ground on which the whales are driven ashore; and he appoints two honest men, who are judicially sworn, to divide them equally. The minister or vicar claims the tithes of the whole, and commonly gets it; the Bailie also claims the heads for his attendance, and if the Admiral finds he has done his duty, the heads are decerned to him, otherwise not." In consequence, however, of frequent disputes that took place on this tripartite division of the whales, the Earl of Morton, who was invested with the droits of Admiralty, appears to have compounded with the landed proprietors of Shetland, by agreeing to accept a definite sum for his share of the capture; but his successors have, I believe, relinquished the claim altogether.

II. *Account of the Ling Fishery at the Haaf.*

On the north of the parish of Northmavine, the low hilly ridges, formed by the sea into deep fissures or caverns, terminate in a line of ragged coast, agreeably diversified by a long narrow peninsula of green land jutting out far into the Northern Ocean, which is named Feideland, an appellation of true Scandinavian origin, that is explained by Debes, in his description of Feroe. He observes, that where grass is found so abundant and juicy, that oxen feed thereon both winter and summer, such places are named *Feidclands;* and it is very remarkable, he adds, that where there are any Feidelands, they invariably turn to the north-east and north. Every where the coast is awfully wild, the peninsula is broken on each side into steep precipices, exhibiting now and then a gaping chasm, through which the sea struggles, while numerous stacks rise from the surface of a turbulent ocean,—the waves beating around them in angry and tumultuous roar. This is a great station for the ling fishery, which commences in the middle of May, and ends on the 12th of August. When any fishermen resort, for the first time, to a convenient place of this kind, they are allowed by the law to build for themselves huts, on any site which may be uninclosed, uncultivated, and at a distance of not more than 100 yards from the high water-mark. These are constructed of rude stones, without any cement, being made no larger than is sufficient to contain a six-oared boat's crew. The men form the roof of thin pieces of wood, on which they lay turf;—they then strew a little straw upon the ground, and snatch from their severe labours a short repose. On the narrow isthmus of low marshy land, that connects the peninsula of Feideland to the Mainland, is interspersed, with all the disorder of a gypsey encampment, a number of these savage huts named *summer lodges*, and in the centre of them is a substantial booth, used by a factor for curing fish. Here I met with excellent accommodation, owing to the kindness of Mr Hoseason, who had sent from his house at Lochend every refreshment I might need, together with a comfortable bed for the evening. Feideland is a place possessing no little interest; a remarkably busy scene is presented by the numerous crews sailing to the Haaf, or returning from it laden with fish;—some men are busily engaged in weighing the stock of ling, cod and tusk, as it is brought in to the factors; others in spreading their lines on the rocks to dry, or in cooking victuals for their comrades who may be employed on the haddock grounds, or in brushing, splitting and salting the fish that are brought to the door of the booth. But to the naturalist, Feideland presents attractions of no mean kind; the numerous rare marine productions that are continually drawn up by the lines of the fishermen, which a small perquisite might induce them to preserve and bring to the shore, would richly repay him for lingering several days in such a station.

I shall now take an opportunity of giving an account of the Ling Fishery, as it is prosecuted at the Haaf.

The *Haaf* is a name applied to any fishing-ground on the outside of the coast, where ling, cod, or tusk may be caught. Not much above a century ago, the fishery for ling and cod was prosecuted much nearer shore than it is now, and fishing places, designated *Raiths*, were pointed out by certain landmarks called Meiths, so that every one knew his own raith, and any undue encroachment upon it was considered no less illegal and actionable, than if it had been upon a landed inclosure. The fishermen, however, at the present day, find it their interest to seek for ling at a much greater distance, even to the extent of thirty or forty miles.

The men employed at the Haaf are from eighteen years of age and upwards. Six tenants join in a boat, their landlords importing for them frames ready modelled and cut out in Norway, which, when put together, form a yawl of six oars, from 18 to 19 feet in keel, and six in beam; it is also furnished with a square sail.

On the 25th of May, or on the 1st of June, the fishermen repair to their several stations. They either endeavour, with rod and line, to procure for bait the fry of the coalfish, of the age of twelve months, named Piltocks, or they obtain at the ebb mussels and limpets; and then going out to sea six miles or more, lay their lines for haddocks, and after obtaining a sufficient supply of these fish, reserve them for bait.

The Feideland Haaf being 30 or 40 miles from land, the fishermen endeavour to leave their station in the morning of one day, so as to be enabled to return in the course of the day following. And if, owing to boisterous weather, they have suffered long detention in their lodges, the first boat that is launched induces every weather-bound crew to imitate the example; it is, therefore, no unusual circumstance to see, in a fleet of yawls, all sails set, and all oars plied, nearly at the same instant of time. Each boat, in the first turn that it makes, observes the course of the sun, and then strives to be the first which shall arrive at the fishing station.

Some few of the fishermen, during their voyage, superstitiously forbear to mention in any other name than one that is Norse, or in some arbitrary word of their own coinage, substituted for it, various objects, such, for instance, as a knife, a church, the clergyman, the devil, or a cat. When after a tug of 30 or 40 miles, the crew has arrived at the Haaf, they prepare to set their *tows*, which is the name they designate the lines by that are fitted with ling-hooks. Forty-five or fifty fathoms of tows constitute a *bught*, and each bught is fitted with from nine to fourteen hooks. It is usual to call twenty bughts a *packie*, and the whole of the packies that a boat carries is a *fleet of tows*. Thus, while a boat in the south or east of Shetland carries only two or three packies, a fleet of tows used on the Feideland Haaf amounts to no less than six, these being baited with seldom less than 1200 hooks, provided with three buoys, and extending to a distance of from 5000 to 6000 fathoms.

The depth at which ling are fished for varies from 50 to 100 fathoms. In setting the tows, one man cuts the fish used for bait into pieces, two men bait and set the lines, and the remaining three or four row the boat. They sink at certain distances what they call *Cappie-stancs*, the first that is let down being called the *Steeth*. These keep the tows properly fixed to the ground. When all this labour is finished, which, in moderate weather, requires three or four hours, and when the last buoy has floated, the fishermen rest for nearly two hours, and take their scanty sustenance; but it is lamentable to think, that their poverty allows them nothing more than oatmeal bread, and a few gallons of water. Their severe labours have never yet excited the commiseration of the British Government; for, owing to the excessive duty on spirits, they can rarely afford to carry with them the smallest supply of whisky.

At length, one man, by means of the buoy-rope, undertakes to haul up the tows,—another extricates the fish from the hooks, and throws them into a place in the stern named the Shot,—a third guts them and deposits their livers and heads in the middle of the boat. Along with the ling that is caught, there is a much less quantity of cod and of the Gadus Brosme or tusk; these are all valuable acquisitions. Six to ten wet lings are about a hundred weight, and hence six or seven score of fish are reckoned a decent haul,—fifteen or sixteen a very good one,—twenty scores of ling are rarely caught, but in such a case, garbage, heads, and small fish, are all thrown overboard, nor can these lighten the boat so much as that she will not appear, according to the phrase of the fishermen, just *lippering* with the water. The skate and halibut which may be taken, are reserved to supply the tables of the fishermen. That formidable looking fish the stone-biter, (Anarhichus Lupus), is also esteemed good eating. When all the tows are heaved up, they are deposited in the bow of the boat.

If the weather be moderate, a crew does not need to be detained at the Feideland Haaf more than a day and a half. But too often a gale comes on,—the men are reluctant to cut their lines, and the most dreadful consequences ensue. About two years ago Mr Watson, the respectable minister of Northmavine, communicated to the editor of an Edinburgh paper a striking instance of the misfortunes to which the fishermen are liable. In speaking of a number of boats that went off to the Haaf, he remarked, that "about the time they were laying their lines, it blew strong from the south-east, so that it was with much difficulty they could haul them in again. The storm increased and blew off land; two boats particularly were in great distress; they having lost their sails, and being quite worn out with fatigue, were able to do very little for their own safety. Luckily the wind shifted to the westward, and on the third day the crews all reached land, completely exhausted with hunger and labour, having had nothing but a very little bread and some water. Two of the men, one in each of the boats which suffered most, died before they came to land, and the rest were not able to walk to their houses without assistance."

III. *Account of the Isle of Stenness, the Holes of Scraada, and the Grind of the Navir.*

The Isle of Stenness, and the Skerry of Eshaness, appear at a short distance, exposed to the uncontrolled fury of the Western Ocean. The isle presents a scene of unequalled desolation. In stormy winters, huge blocks of stones are overturned, or are removed far from their native beds, and hurried up a slight acclivity to a distance almost incredible. In the winter of 1802, a tabular-shaped mass, 8 feet 2 inches, by 7 feet, and 5 feet 1 inch thick, was dislodged from its bed, and removed to a distance of from 80 to 90 feet. I measured the recent bed from which a block had been carried away the preceding winter (A. D. 1818), and found it to be 17½ feet by 7 feet, and the depth 2 feet 8 inches. The removed mass had been borne to a distance of 30 feet, when it was shivered into thirteen or more lesser fragments, some of which were carried still farther, from 30 to 120 feet. A block, 9 feet 2 inches by 6½ feet, and 4 feet thick, was hurried up the acclivity to a distance of 150 feet. Such is the devastation that has taken place amidst this wreck of nature. Close to the Isle of Stenness is the Skerry of Eshaness, formidably rising from the sea, and shewing on its westerly side a steep precipice, against which all the force of the Atlantic seems to have been expended: it affords a refuge for myriads of kittiwakes, whose shrill cries, mingling with the dashing of the waters, wildly accord with the terrific scene that is presented on every side.

The fishing station of Stenness is occupied by the tenants of Messrs Cheyne, who, from the liberal manner in which they are treated, bear the character of being the best fishermen in the country. About seventy boats are annually employed at the Stenness Haaf. It is computed, that between the middle of May and the 12th of August, when the ling fishery ceases, a boat makes about eighteen trips to the Haaf. Most of the ling, cod, and tusk that are cured in Northmavine go to Ireland; other markets are found for them by Scottish and English merchants, in Barcelona, Lisbon, Ancona, and Hamburgh. The dangers that the boats run at the Haaf have often suggested the expediency of employing small decked vessels for the fishery. Accordingly, there was an undertaking of this kind set on foot about half a century ago, but it was in every respect ill managed, and failed.

Leaving Eshaness, where may be observed an immense block of granite, not less than three yards in diameter, thrown up by the sea, I pursued my way north, along a high gradually ascending ridge that impends the ocean, which is covered with the finest and softest sward that ever refreshed the tired feet of the traveller, being frequently resorted to by the inhabitants of Northmavine, on a fine Sabbath evening, as a sort of promenade. The verdure that embroiders this proud bank, on which numerous sheep continually feed, pleasingly harmonizes, on a calm day, with the glassy surface of the wide Atlantic; nor is the pleasure less perfect, when the smooth coating of so luxuriant a green turf is contrasted with the naked red crags that form the precipice below, whitened with the spray of the breakers which continually dash against them with angry roaring. The rich surface of pasture that thus gradually shelves from the elevated ridge of the coast, bears the name of the Villians of Ure;—and well might we apply to this favoured spot of Thule, the compliment that has been often paid to some rich vale of England,—"Fairies joy in its soil." After a distance of three miles, this gladdening prospect of fertility is suddenly closed with the harsher features that Hialtland usually wears. Near the mountain lake of Houland, where a burgh, built on a holm close to its shore, displays its mouldering walls, the coast resumes its wild aspect.

A large cavernous aperture, ninety feet wide, shows the commencement of two contiguous immense perforations, named the Holes of Scraada, where, in one of them that runs 250 feet into the land, the sea flows to its utmost extremity. Each has an opening at a distance from the ocean, by which the light of the sun is partially admitted. Farther north, other ravages of the ocean are displayed. A mass of rock, the average dimensions of which may perhaps be rated at twelve or thirteen feet square, and four and a half or five feet in thickness, was first moved from its bed, about fifty years ago, to a distance of thirty feet, and has since been twice turned over. But the most sublime scene is where a mural pile of porphyry, escaping the process of disintegration that is devastating the coast, appears to have been left as a sort of rampart against the inroads of the ocean; —the Atlantic, when provoked by wintry gales, batters against it with all the force of real artillery,—the waves having in their repeated assaults forced for themselves an entrance. This breach, named the Grind of the Navir, is widened every winter by the overwhelming surge, that, finding a passage through it, separates large stones from its side, and forces them to a distance of no less than 180 feet. In two or three spots, the fragments which have been detached are brought together in immense heaps, that appear as an accumulation of cubical masses, the product of some quarry.

IV. *Account of the Religious Paroxysms of the Shetlanders.*

The kirk was remarkably crowded, since there was a sermon to be preached incidental to the administration of the Sacrament; on which occasion I had an opportunity of seeing the convulsion fits to which the religious congregations of Shetland are subject. The introduction of this malady into the country is referred to a date of nearly a century ago, and is attributed to a woman who had been subject to regular paroxysms of epilepsy, one of which occurred during divine service. Among adult females, and children of the male sex, at the tender age of six, fits then became sympathetic. The patient complained, for a considerable time, of a palpitation of the heart; fainting ensued, and a motionless state lasted for more than an hour. But, in the course of time, this malady is said to have undergone a modification such as it exhibits at the present day. The female, whom it had attacked, would suddenly fall down, toss her arms about, writhe her body into various shapes, move her head suddenly from side to side, and, with eyes fixed and staring, send forth the most dismal cries. If the fit had occurred on any occasion of public diversion, she would, as soon as it had ceased, mix with her companions, and continue her amusement as if nothing had happened. Paroxysms of this kind prevailed most during the warm months of summer; and about fifty years ago, there was scarcely a Sabbath in which they did not occur. Strong passions of the mind, induced by religious enthusiasm, were also the exciting causes of these fits; but, like all such false tokens of divine workings, they were easily counteracted, by producing in patients such opposite states of mind, as arise from a sense of shame: thus they are under the controul of any sensible preacher, who will administer to a mind diseased,—who will expose the folly of voluntarily yielding to a sympathy so easily resisted, or of inviting such attacks by affectation. An intelligent and pious minister of Shetland informed me, that being considerably annoyed on his first introduction into the country by these paroxysms, whereby the devotions of the church were much impeded, he obviated their repetition, by assuring his parishioners, that no treatment was more effectual than immersion in cold water, and as his kirk was fortunately contiguous to a fresh-water lake, he gave notice that attendants should be at hand, during divine service, to ensure the proper means of cure. The sequel need scarcely be told. The fear of being carried out of the church, and into the water, acted like a charm; not a single Naiad was made, and the worthy minister has, for many years, had reason to boast of one of the best regulated congregations in Shetland.

When I attended the kirk of Baliasta, a female shriek, the indication of a convulsion-fit, was heard; the minister (Mr Ingram of Fetlar) very properly stopped his discourse, until the disturber was removed; and after advising all those who thought they might be similarly affected, to leave the church, he gave out in the mean time a psalm. The congregation was thus preserved from farther interruption; for, on leaving the kirk, I saw several females writhing and tossing about their arms on the green grass, who durst not, for fear of a censure from the pulpit, exhibit themselves after this manner within the sacred walls of the kirk.

V. *Account of the Teutonic Fortress, called the Burgh of Mousa.*

I passed along the shore of the open bay of Sandwick, which has been the grave of many seamen, who, by mistaking it for Bressay Harbour, have suffered all the horrors of shipwreck upon its exposed shores. In crossing a headland to the east of the Inlet, a small low island, named Mousa, separated from the Mainland by a narrow strait, first rises to view: this spot is little diversified with hill and dale; it contains one good house with out-buildings and cottages. But the most conspicuous object that lines its shores is the Burgh of Mousa, a circular building, which, if it did but taper towards its summit, would present no unapt similitude of a modern glass-house. This ancient fortress stands close to the water's edge; by crossing, therefore, in a boat, a narrow channel, little more than half a mile in breadth, we are landed immediately under its walls.

The Burgh of Mousa occupies a circular site of ground, somewhat more than fifty feet in diameter, being constructed of middle sized schistose stones of tolerable uniform magnitude, well laid together, without the intervention of any cement. This very simple round edifice attains the elevation of 42 feet; it swells out, or bulges from its foundation, and draws smaller as it approaches the top, when it is again cast out from its lesser diameter; which singularity of construction is intended to obviate the possibility of scaling the walls. The door that leads to the open area contained within the structure, is a small narrow passage, so low that an entrance is only to be accomplished by crawling upon the hands and knees; and in creeping through it, the wall appears of the great thickness of 15 feet, naturally leading to the suspicion of a vacuity within. On arriving at the open circular area included within this mural shell, I found the diameter of the space to be about 21 feet. On that part of the wall within the court, which is nearly opposite to the entrance, the attention is excited by a number of small apertures resembling the holes of a pigeon-house. There are three or four vertical rows of them, having each an unequal proportion of openings, varying from eight to eighteen in number. It was now evident that the mural shell of the structure was hollow, and that it contained chambers, to which these holes imparted a feeble supply of light and air. Beneath the whole, at a little distance from the ground, there is a door that leads to a winding flight of stone steps, of the width of 3 feet, which communicates with all these apartments: I then discovered that the shell of the Burgh was composed of two concentric walls, each of about 4½ to 5 feet in breadth, and that a space of nearly a similar dimension was devoted to the construction of the inner apartments. In ascending these steps, which wound gradually to the top of the wall, I observed that they communicated at regular intervals with many chambers or galleries, one above another, that went round the building. These were severally of such a height, that it was possible to walk within them nearly upright. The roof of the lowest chamber was the floor of the second, and after this manner seven tiers were raised. On reaching the highest step of the flight of stairs, there appeared no reason for supposing that any roof had ever protected the summit of the building, so that the Burgh of Mousa must have been originally nothing more than a circular mural shell, open to the top. The height of the inside wall was 35 feet, being 7 feet less than that of the outside; this difference was partly owing to the accumulation of stones and earth, which had filled the inner court.

The mode was now evident in which this Burgh had been intended to give security to the persons and property of the ancient inhabitants of Shetland against the sudden landing of predatory adventurers. The tiers of apartments contained within the thick walls would afford a shelter to women and children from the missile weapons of assaulters, besides being repositories for grain and other kinds of property, as well as for the stores whereby a long siege might be sustained. The low narrow door within the court, which admits of no entrance but in a creeping posture, might be easily secured at a short notice by large blocks of stone. It has been remarked of the rude forts similar to these which occur on the shores of Scandinavia, that they were seldom taken by an enemy, unless by surprise, or after a long blockade; that frequently terraces and artificial banks were raised near that side of the wall which was the lowest, and that the besieged were then annoyed with arrows, stones, boiling-water, or melted pitch, being thrown into the fort;—offensive weapons which they did not neglect to return. The history of the Burgh of Mousa confirms the correctness of this observation; its high walls bulging out from their foundation, defied any attempt to scale them; for, when they were encompassed by one of the Earls of Orkney, he had no hopes of inducing the fortress to surrender, but by cutting off all supplies of food, and then waiting the event of a long siege. Altogether the building was well adapted for resisting the attacks of the ancient piratical hordes of these seas, who, from the short summers of northern latitudes, and from the incapability of their vessels to sustain a winter's navigation, durst not allow themselves to be detained on the coast by any tedious operations of assault.

Before quitting the Burgh of Mousa, I endeavoured to explore some of the chambers belonging to it, but owing to the ruined state of the floors, the attempt was too hazardous. A lively historian has remarked, that in Scandinavia, such recesses were often devoted in days of yore to the security of young damsels of distinction, who were never safe while so many bold warriors were rambling up and down in quest of adventures. It is also surmised, that galleries like these which run winding around the walls, were, from the direction which they took, not unfrequently distinguished by the name of Serpents or Dragons; and hence the many allegorical romaunts that were coined concerning princesses of great beauty being guarded by such monsters. It is unlucky, however, for the historical interest of the Dragon-fortress of Mousa, that within the dismal serpentine windings of its apartments, was confined a damsel past her prime of life, and as well entitled to be "shrined for her brittleness," as any of the frail heroines of antiquity. In the fourteenth century, when, by the rights of udal succession, there were joint Earls of Orkney, Dame Margareta, the widowed-mother of one of them, listened to the lawless importunity of the gay Brunnius. Harold, her son, became impatient of the family disgrace, and banished from the islands his mother's paramour, as well as the illegitimate offspring that were the fruits of the connection. But, in the course of a short time, Dame Margareta's beauties attracted the notice of a more honourable suitor, who was no other than Harold's partner in the Earldom of Orkney and Shetland. Erlend proferred love to the Dame, which she returned, but as her son, from some cause, was averse to the nuptials, the parties entered into a tender engagement without his consent, and afterwards fled from his fury with all speed into Mousa. Then must Harold needs follow them, his hostile barks sailing in pursuit, as fast as if all the winds of heaven had driven them; and then, anon, fled the dame Margareta and Erlend into the fort, within the dark recesses of which they nestled like two pigeons in a dovecot. The Burgh was beset with troops, but so impregnable was its construction, that the assaulter found he had no chance of reducing it, but by cutting off all supplies of food, and by this means waiting the result of a tedious siege. And now turn we to the gentle pair in the fortress, that we may speak of what pain they must there endure, what cold, what hunger, and what thirst. In such a dog-hole,—"a conjurer's circle gives content above it;—a hawk's mew is a princely palace to it."—But Harold had powerful foes in other places wherewith to contend, and, on this account, he gave heed to the advice of his followers, that Erlend should be retained as a friend and not as an enemy, and that he ought not to despise the new family alliance. A reconciliation took place, and then, with great joy, returned the parties to their several pursuits, well satisfied with each other. Such is the story chronicled by Torfæus, concerning the siege of Moseyaburgum and the loves of Dame Margareta and Erlend, her last leman.

VI. *Method of Bloodletting in Shetland.*

In Shetland there are several native popular medicines. Scurvy grass, for instance, is used in cutaneous complaints, butter-milk in dropsy, the shells of whelks calcined and pounded for dyspepsia, and a variety of steatite named in the country *kleber*, for excoriations. But the mode of letting blood, known from time immemorial, deserves the most particular notice. When the native chirurgeon is called in, he first bathes the part from which the detraction is to be made, with warm water, and then draws forth his cupping-machine, which consists of nothing more than the upper part of a ram's horn perforated at the top, and bound round with a soft piece of cotton or woollen rag. In applying it to the skin, he sucks out a little of the included air, takes off the horn, makes upon the surface of the part that has thus been gently raised six or seven slight incisions, again fixes the cupping instrument, freely draws out the air by the reapplication of his lips to it, and, either by insinuating his tongue within the perforation, or by twisting round it a piece of leather or bladder, prevents the ingress of fresh air. He next uses coarse cloths, wrung out with warm water, to stimulate the flowing of the blood, and when the horn is half filled, it leaves the skin and falls down. The same process is repeated several times, until a sufficient depletion has been made. It is worthy of remark, that the African negroes, described by Park, have a similar mode of cupping.

ART. VIII.—*On the Ancient History of Leguminous Fruits*

By Professor LINK. (Concluded from Vol. V. p. 131.)

OCIMUM (ὤκιμον) is reckoned by Theophrastus, in the often quoted passage among greens. It has a woody root, like εὔζωμον, (*H. Pl.* l. i. c. 6. § 6. *Schn.*), and is propagated by shoots (ἀπὸ βλαστῶν) like ὀρίγανος, (l. vi. c. 2. § 1.), the root simple and thick, (§ 7.) Dioscorides (l. ii. c. 171.) does not describe the plant; Galen says it is difficult of digestion, (*Op. Basil.* iv. 333.). Our Basil (*Ocimum basilicum*) has been suspected to be the plant, but it does not correspond. Sprengel (*Geschichte der Botanik*) quotes a passage from Belon's Travels, (ii. c. 40.), in which it is said, that *Ocimum* or *Basilicum* grows three times as high in the East as with us, and is cultivated as greens. But has not Belon taken another plant for it? The testimony of the ancients is not so distinct as that we can rest on that account.

Μάραθρον, *Fœniculum* of the Romans, is placed by Galen among pot-herbs, and ranked with *Anethum*, which is more used as a seasoning to food. Theophrastus ascribes to it a naked seed, ranks it with coriander, (*H. Pl.* l. i. c. 11. § 2.) calls it sweet-smelling, when joined with other umbelliferous plants (c. 12. § 2.), and places it among the *ferulaceæ* and πυρόκαυλα, (l. vi. c. 1. § 4.) Galen and Dioscorides do not describe the Fennel. The general agreement, even of different languages,—the comparison with other plants,—even the properties that have been mentioned, preclude any doubt of μάραθρον being our Fennel. It is eaten in the south of Europe as greens. As little can we doubt that the ἄνηθον, νάπυ, κάρδαμον, θύμβρον of the ancients, although not described, (Theophrastus ascribes to it a woody root, *Hist. Pl.* l. vii. c. 2. § 8.), yet, when compared with other umbelliferous plants, in respect to the uses made of it, and the general agreement, is our Dill, (*Anethum graveolens*). The same thing applies to κορίαννον, which is probably our Coriander. Of the umbelliferous plants, many are eaten by us as greens, for instance, *Scandix cerefolium*, *Myrrhis odorata*, *Chærophyllum sylvestre*, *Ægopodium Podagraria*, and several others, sometimes by themselves, sometimes along with other plants. Dioscorides mentions three such edible plants, γιγγίδιον, which is plentiful in Syria and Cilicia, and σκάνδυξ and καύκαλις, (l. ii. c. 167.—169.) The first has leaves like those of the wild carrot, (*Daucus Carota sylvestris*), but finer, and of a bitter taste, and also a white and bitter root. *Daucus Gingidium*, which grows wild in the south of France, is very probably another plant. Σκάνδυξ is somewhat sharp, bitter, and edible. This is not the case with *Myrrhis odorata* or *Scandix cerefolium*, which have rather a sweet taste and a pleasant smell. Σκάνδυξ is often mentioned by the Greeks, because this plant was much used at Athens by the poor as greens. Καύκαλις has leaves like fennel, a white, sweet-smelling umbel, and is eaten both raw and dressed. It is therefore none of the species which we now call *Caucalis*. Theophrastus makes no mention of this plant. I dare not venture to determine it.

Σέλινον of the Greeks, *Apium* of the Romans, appears to be our Parsley, (*Apium petroselinum*). The curled variety, not common among umbelliferous plants, distinguishes this plant, and is distinctly named by Theophrastus, (*Hist. Pl.* l. vii. c. 4. § 6.), as also by Pliny, (l. xix. c. 8.) and others. It is not classed among the *Olera*, but among the *Condimenta*. All that the ancients say of *apium* contradicts not this description. Only the σέλινον ἐλεοθρεπτὸν of the poets has been considered to be *Apium graveolens*; for which opinion I know no reason, since parsley grows in moist, boggy places. Although Dioscorides says of ἐλειοσέλινον (l. iii. c. 74.), it is larger than the garden σέλινον, it is yet too rash to conclude that it is *Apium graveolens*. Linnæus mentions Sardinia as the native country of parsley; but it is found wild throughout the whole north of Europe, in mountainous tracts, by pools, and in moist meadows. The finely divided leaf was early noticed by the ancients, and used as garlands, (for example, by the poets in the Nemean Games). The ancients prized the pure form more than we do: they admired the leaf of the Acanthus, but speak nothing of its flower; at present we prefer flowers to leaves. I find no notice among the ancients of the use of Celery (*Apium graveolens*) as a relish. Beckman remarks, that in the year 1690, the gardener Hess speaks of celery as a garden plant which had but lately become known. But John Bauhin says it was early transferred to the gardens, only it is softer than the wild parsley. Probably the leaf was first used, then the root, as the use of the root of parsley is more recent than the leaf. Celery grows in the northern and central parts of Europe, but not in the southern, within 39° N. Lat. Instead of celery, the roots of *Smirnium olus atrum* were formerly in use, and the leaves were eaten as greens. This is still done in the south of Europe. This plant is the σμυρνίον of the ancients, as the excellent description of Dioscorides (l. ii. c. 29.) shews; the *Olus atrum* of the Romans. It grows wild every where in the south of Europe, in the bushes and hedges. Probably its resemblance to celery may have led to the cultivation of this latter plant.

Κάρδαμον is placed by Theophrastus among the λάχανα, (*Hist. Pl.* l. vii. c. 5.) The Romans translated the word into *Nasturtium*. This plant is frequently mentioned by writers, but no where described or exactly marked out; but it is always quoted as a sharp-tasted plant. It is extremely probable that it ought to be classed among plants of the cress kind, but it is difficult to determine to which species, especially as different plants of this natural order are eaten as cresses.

The use of Rocket (*Brassica Eruca*) is much lost; and even in Bauhin's time, it was only now and then reared in the garden. It was much prized by the ancients. Galen says that the leaves could not be eaten by themselves as cabbage, on account of their sharp taste, but that they are mixed with lettuce, which is also quoted by Pliny, (l. xix. c. 36.) In general, it was rather used as food than as seasoning. It had the name εὔζωμον, from its giving broth a pleasant taste. Formerly the seeds were used as they now are, for mustard; and Dioscorides mentions only this use, which seems, indeed, to have been by far the most frequent. That the *eruca* of the ancients was our Rocket, is proved by the agreement of all its names, *Rocchetta*, *Roquetta*, *Rauke;* and none of its characters contradicts this idea. It grows wild in the central and southern parts of Europe. Our Mustard, three species of which were distinguished by the ancients, *Sinapis nigra*, *alba*, and *arvensis*, was not less frequently used by them than by us, as well for seasoning food, as for medicine, and for obtaining oil. All these plants grow wild in Europe

In Theophrastus's Hist. Pl. l. vii. c. 1., θύμβρον also is placed among the greens. Dioscorides (l. iii. c. 45.) distinguishes a wild θύμβρα from that which grows in the gardens, and adds, that the latter is milder, and better for eating. We may well suspect that a seasoning plant, as *Thymian saturcia*, or some similar plant, is meant; but, from the scanty notices of the ancients, it is difficult to determine it.

From the earliest times, the Leek species has been used as a seasoning for food. The Homeric heroes eat nothing but flesh; only as a seasoning to their drink, Hecameda presents to old Nestor κρόμμυον ποτῷ ὄψον, (*Il.* λ 629.) Κρόμμυον is the onion, (*Allium cepa*), according to all opinions; and what Theophrastus says respecting its propagation, (*Hist. Pl.* l. vii. c. 4. § 10.), namely, that one onion has no other accessory ones attached to it, points it out distinctly. There were formerly, as there are now, many varieties, which were named after the places where they were chiefly cultivated. Respecting the places of their origin, there is not even a suspicion. Κρόμμυα ἀσκαλώνια are by no means our Shallot, (*Allium Ascalonicum*), as is generally supposed, but probably a variety of the onion. For Theophrastus says, (a. a. O. § 8.), this species is propagated by seed, and in no other way, which is quite the reverse of the manner in which shallots are propagated. According to Linnæus, shallots are used in Palestine, and he quotes Hasselquist as an evidence. In his Travels, I find only that he found *Allium pallens* and *veronense* on the Hill of Zion. The κρόμμυα σχίστα, are that variety of the onion, or perhaps that particular species, which sends out young bulbs, and is propagated by means of them. It is the *Cepa fissilis* of the old botanists; but the word *fissilis* must not be misunderstood.—(See Schneider's *Anmerkungen* on this passage). Γήθυον, or, as Schneider uses the word, γήτυον, is the winter onion, (*Allium fistulosum*). It has nothing like *A. cepa*, except a long neck: the leaves are often cut at the top, as in πράσον, (Theophr. l. c. § 10.) Hence it is sowed, and not planted. All this agrees exactly with our winter onion, and by no means with the *Cepa fissilis*, which is propagated, not by seed, but by bulbs. Therefore Diocles Carystius in Athenæus, says rightly, (l. ii. c. 78.) ἀσκαλώνια and γήτυον were species of κρόμμυον. It is also said there to be like the *Ampeloprasus*. The πράσον of the ancients is not *A. porrum*, but *A. ampcloprasum* of the older botanists; for it is said of the onion (Theophr. loc. cit.

§ 2.) that it sends out young bulbs below; and therein lies the distinction between *A. porrum* and *A. ampeloprasum*. Linnæus says distinctly enough of *A. ampeloprasum*, *Habitat in oriente, et insula Holm Angliæ.* The first of these circumstances is founded on the fact, that this plant was first introduced at Constantinople; the other on an old notice of a person called Newton, who probably confounded this plant with *A. scorodoprasum.* What the *Ampeloprasum* of the ancients was, we cannot determine, from the scanty characteristics of it which have been left. Perhaps it is *A. porrum*. This plant, which is at present generally used, grows wild, according to Linnæus, in Switzerland; but Haller has doubts upon that point. In Athenæus, γήτειον is said to be like the *Ampeloprasum*; and as γήτειον is not used in more recent writings, it has probably given place to *Ampeloprasum*. The *Scorodoprasum* of the ancients may be considered as the *A. scorodoprasum* of the moderns, that is to say, the *Ophioscorodon* of the ancient botanists. The *A. scorodoprasum* of Linnæus is little or nothing different from *A. arenarium.* As the difference could not be determined, some writers, as for instance Willdenow, considered the *Ophioscorodon* to be quite a different plant, which Linnæus had taken for a variety of *A. scorodoprasum.* Σκόροδον, in fine, is *A. sativum*, without doubt. What the ancients say of its strong smell,—of its propagation, which is by bulbs, but likewise, although more tardily, by seed,—agrees perfectly with this. According to Linnæus, garlic grows wild in Sicily; but this opinion is founded on an ancient and very doubtful notice of Cupanus. Among the cultivated leek species, we are only acquainted with the birth-place of *A. schænoprasum*, which grows wild on the mountains of southern Europe, but was not cultivated, so far as I know, by the ancients.

What the *Asparagus* of the ancients in general was, we are informed by Galen, (*De Aliment. Facult.* l. ii.), namely, the young shoots of various plants, as, for example of Lettuce, Mallows, Beet, Lapathum, and some others which are eaten. *Asparagus*, in Theophrastus, is one of the prickly species of the genus Asparagus, which grow in the south of Europe. Dioscorides describes a garden asparagus so exactly, that it is impossible to doubt that it is our common asparagus. It was eaten, too, and its effects were the same with those of our asparagus.

The culture of asparagus, as Cato has described it, (c. 61.), also corresponds with that of this plant. We learn from Galen that the ancients not only ate the young stems of many plants, but the young shoots of many trees and bushes, for instance *Pistacia terebinthus*, *Vitex Agnus castus*, and others.

The turnip (*Brassica rapa*) is probably a variety of the *Brassica napus*, as the large and small turnip are not different in species. Turnips were well known to the ancients, and they had several varieties, which it is not easy to determine. This much is clear from Columella's notices, (l. ii. c. 10. § 23.), that *rapum* was the large turnip, which was used for fodder, *napum* the small turnip. Theophrastus (l. vii. c. 4. § 4.) mentions two species of γογγυλίς, the male and female. Athenæus quotes ῥαφανίς, γογγυλίς, ῥάφος, ἀνάῤῥινον, βουνιάς, (l. ii. c. 130.—134.) but without any more precise notices. Pliny translates γογγυλίς by *rapum*, ῥαφανίς by *napum*, (l. xix. c. 5.). Galen considers βουνιάς to have the same meaning with γογγυλή, (*De Aliment. Facult.* l. ii.). The names were thus determined, except some in Athenæus, which can no longer be defined. The plant seems to be a native of central Europe, for it is often found in countries where its cultivation is quite unusual, and always as *Brassica napus*

The Romans correctly enough denoted our Radish by the name *Raphanus*, (Plin. l. xix. c. 5.); and a smaller subspecies, called *Radix Syriaca*, had been brought from the east not long before Pliny's time. Probably the radish came at a late period from the east into Greece, and obtained the name ῥαφανός, which word had signified cabbage, or κραμβή, perhaps from its resemblance to cabbage. The radish is extensively cultivated in the east, and in Mysore. Linnæus places its native country in China, probably from confounding it with the Chinese oil-radish, which seems to be a native of that country. The true native country of it remains uncertain. In Egypt formerly an oil-radish was cultivated, (Plin. l. xix. c. 5.).

Beckmann has distinctly shewn, in his History of Inventions, (P. 4. s. 134.), that our Carrot is the *Staphylinus* of the ancients, and our parsnip their *Elaphoboscum*. The description of the latter in Dioscorides (l. iii. c. 80.), is very precise. Thus Dioscorides (l. iii. c. 60.) speaks under *Staphylinus* of the red flower in the centre of the umbel, which is proper only to the species of the genus *Daucus.* Columella (l. ix. c. 4.) translates *Staphylinus,* which is the Greek name, by *Pastinaca,* under which, therefore, our parsnip is by no means included. The *Daucus* of the ancients was a medicinal plant, (Theophr. *Hist. Pl.* l. ix. c. 22., and Dioscorides, l. iii. c. 83.), which Pliny has translated by *Pastinaca* (l. xix. c. 5.), and thereby has made and occasioned great mistakes. This error has been increased by the circumstance, that some writers, as Galen says, give the name *Daucus* to the wild *Staphylinus.* The carrot (*Daucus carota*) grows every where wild with us, as well as the parsnip, (*Pastinaca sativa*). Dioscorides says the wild *Staphylinus* is also eaten, and Athenæus quotes a passage from Diphylus, wherein it is said, that the *Staphylinus* is sharp-tasted, (l. ix. c. 12.) In the north of Europe, there grows a wild species of *Daucus,* which much more resembles our cultivated carrot than the species which grows wild with us, and by means of which, the passages of the ancients are made more intelligible. The name Carrot is old: the large and full grown plants, says Diphylus in Athenæus, are called καρῶτοι. In Galen, κάρος is probably used for καρῶτος.

Sisaron of the ancients was the common name for our Skirret (*Sium sisarum*). Dioscorides (l. ii. c. 139.) says little distinct about it: the roots are pleasant to eat. It is not easy to say whether the σιόν of Athenæus be the same (l. 2. c. 18.), since even in this author nothing certain is found. The *Sium* of Dioscorides is various, and always a medicinal plant. Columella says, *Jam siser Assyrio venit quæ semine radix* (l. x. v. 114.); according to which the plant ought to belong to the East. We ought probably also to place the native region of skirret there, since this plant does not grow in any part of Europe, and its use is very ancient. Linnæus says of *Sium sisarum: Habitat in China,* probably because *Sium ninsi* grows there. But the proper *Ninsi* is different. Galen quotes *Siser* only among the medicinal plants, and speaks of its bitterness. He means, therefore, a plant different from our skirret. Pliny says of *Siser* (l. 19. c. 5.), that it grows in Germany, the best kind of it near Gelduba, a Castle on the Rhine,—that it was always brought from Yormaus by Tiberius, who was very fond of it; and that it has a very bitter root, which is sweetened by *Must*. He evidently means a different *Siser* from that of Dioscorides. The ancients thus used the name *Siser* for different plants; and although at first it signified skirret, it was afterwards applied to many other plants, which cannot easily be ascertained.

At this day the root of *Arum Colocasia*, is much eaten in Egypt. The ancients named it *Arum* or *Colocasia*, and of the species there is no doubt. The similar root of *Arum maculatum*, and still more of it, *italicum*, was often confounded with it, and Galen speaks of both species under the same name. Sometimes also, the root of *Dracontium*, he says, was eaten, which has a sharp taste, and must be frequently dressed. It is *Arum Dracunculus*. *Arum Colocasia* grows wild in Egypt, the other two species are found in the South of Europe

Sprengel, in the *Antiquit. botan.* p. 68., treats circumstantially and precisely of *Asphodelus*. In ancient times its tubers were eaten, as we learn from a passage in Hesiod. Dioscorides, also, when treating of edible roots and bulbs, speaks of *Asphodelus*. Sprengel says, very justly, that *Asphodelus* in Galen does not denote *Asphodelus ramosus*, for he speaks of a bulb like that of *Scilla*, whilst *Asphodelus ramosus* carries tubers. It is also a suspicious circumstance, that Dioscorides speaks of the sharpness of the tubers, whilst in *Asphodelus ramosus*, the tubers have no sharp point, as we learn from Bauhin and from experience. It is also probable, that among the ancients this plant was confounded with some related plants, perhaps with the large species of *Ornithogalus*.

Equally difficult is it to say what was the edible bulb of the ancients, (*Bulbus esculentus*). Many passages in Theophrastus teach us nothing more than that the plant was a bulbous plant. This author even says, that there are different kinds of bulbs, some of which were edible, and might be eaten raw, as is the practice in *Chersonesus taurica*. Dioscorides speaks of βόλβος ἐδώδιμος, as a well known bulb, but adds, that those which are brought from Lybia are red, and agree well with the stomach. The bitter species, and that which resembles the squill, agrees still better with the stomach, (l. ii. c. 200.). Galen also speaks of its bitterness, and says, that in spring the young shoots are eaten (*asparagus*). Pliny confounds a number of plants under this title. The bulb of *Megara* is repeatedly mentioned by the ancients, as well as its stimulating property in general. Columella says, (l. x. v. 105.) *Quæque viros acuunt, armantque puellas, Jam Megaris veniant genitalia semina bulbi.* The poets, in many passages, speak of this bulb. It has been suspected to be *Hyacinthus comosus,* but only suspected, without any sufficient reason.

Many roots have been cultivated and eaten in modern times. The scorzonera (*Scorzonera Hispanica*) was first brought into Catalonia about the end of the fifteenth century, as an article of food, as we learn from Manardes, in his treatise *de lapide Bezoar et radice Scorzoneræ.* At a more recent period came the goat's beard, (*Tragopogon porrifolius*). Anciently, but only here and there, the *Chærophyllum bulbosum* was cultivated on account of its tubers, as also *Campanula rapunculus. Oenothera biennis,* a North American plant, which has become wild in Europe, has also been cultivated on account of its edible root.

Beckmann has given very exactly the history of the Artichoke (*Cynara Scolymus*), in his History of Inventions, (p. 2. l. 190). That *Cynara* and *Cactus* are the same plants, seems to be proved by the notions which Athenæus and Pliny gives. But it is not clear whether they meant *Cynara Scolymus*, the artichoke, or *Cynara carduncculus,* the cardoon; and as they say, after Theophrastus, that the blanched flower-stalks and leaf-stalks especially were eaten, it is likely that the latter plant was meant. It is then related in what way the culture of the artichoke was first introduced in 1473 by the Venetians. The cardoon grows wild in the South of Europe. The artichoke is not found wild, and probably it is only a subspecies of the cardoon, which has been produced by careful culture.

The *Scolymus* of the ancients is evidently *Scolymus Hispanicus,* which grows wild not merely in Spain, but generally over all the South of Europe. According to Dioscorides (l. 3. c. 16.) and others, it was eaten. To this day, in several countries of the South of Europe, the root, receptacle, peeled nerves of the leaves, and young stems are eaten.

The pumpkin and cucumber have been known from early times, and are reared as esculent fruits. But their native country is unknown to us. According to Linnæus, the melon grows wild in the country of the Kalmucks, but other writers say nothing of this. Linnæus places the native country of the cucumber in Tartary and the East Indies, but these two countries are very different, and the account has been copied from Gütdunk. Modern botanists confess that they know not its birth-place. Of the pumpkin Linnæus says, *Habitat in Oriente*, which account is equally uncertain. The water-melon is said to grow wild in Apulia, Calabria, and Sicily, but though they are of frequent occurrence in those countries, they have never been found in their wild state. All authors complain of the difficulty of ascertaining the names of these fruits among the ancients. The fruits were so well known, that no person thought of taking the trouble to do more than mention their names. Theophrastus uses only σίκυος and κολοκύνθη, and some subspecies of the first. Dioscorides uses κολοκύνθη, σίκυς ἥμερος and πέπων. Galen uses κολοκύνθη, πέπων μηλοπέπων, σίκυος (*de alimentor. facult.* l. ii.). Of the first he says, that when raw it is unpleasant to eat, and indigestible. Speaking of the μηλοπέπων, he says, that the interior part of the flesh of the πέπων, in which the seeds are not eaten, but that the μηλοπέπων is so used. Of σίκυος he says, some persons readily digest it, but that proceeds from a particular constitution of stomach. There is no doubt, therefore, that κολοκύνθη is the pumpkin, and πέπων the melon. Athenæus says (l. ii. c. 53.), that the κολοκύνθη was called by Euthydemos σίκυα Ἰνδικη, because the seeds came from India. On the shores of the Hellespont, the long fruits are called σίκυα, the round ones κολοκύνθας. In another passage, he says (c. 78.), the κολοκύνθαι are not eatable unless when dressed. Both names, therefore, signify the pumpkin, but σίκυα is seldom used. The short preceding passage has been lost, and is difficult of explanation; but it is quite evident, that σίκυος and πέπων might be eaten raw, although only when the former was small and tender. Κολοκύνθη is translated by the Romans *cucurbita*, σίκυος is rendered *cucumis*, πέπων answers to *pepo*, to which may be added *melones*, probably for μηλοπέπων. Pliny is full of mistakes. Apicius says, the *cucurbita* are used only dressed, but *cucu-*

meres peeled and pickled, *pepo* and *melo* pickled together, (l. iii. c. 4.–6.). From all this it is clear, that κολοκύνθη, *cucurbita* was the pumpkin, and that σίκυς was the cucumber: it is also plain, that πέπων, *pepo* the melon, but μηλοπεπων, *melo*, remains undetermined. It has been suspected to be the water-melon, but Galen says it is less watery than the πέπων.

ART. IX.—*On the Extraordinary Darkness that was observed in some parts of the United States and Canada, in the month of November* 1819. By FREDERICK HALL, Professor of Mathematics and Natural Philosophy in Middlebury College, Vermont *.

THIS phenomenon first attracted my attention on the morning of the 9th of November 1819. I rose at a quarter before seven, and found it much darker than it ordinarily is in the evening at the time of full moon. It snowed fast for about an hour; this was succeeded by a moderate rain, which continued most of the day. Being occupied, I took no farther notice of the uncommon darkness till about nine o'clock. At this time, the obscurity, instead of diminishing, had considerably increased. The thermometer stood at 34°. A strong, steady, but not violent wind, blew from the south.

The darkness was so great, that a person, when sitting by a window, could not see to read a book, in small type, without serious inconvenience. Several of the students in the college studied the whole day by candle-light. A number of the mechanics in this village were unable to carry on their work without the assistance of lamps.

The sky exhibited a pale yellowish-white aspect, which, in some degree, resembled the evening twilight a few moments before it disappears. Indeed we had little else but twilight through the day; and such, too, as takes place when the sun is five or six degrees below the horizon. The colour of objects was very remarkable. Every thing I beheld wore a dull, smoky, melancholy appearance. The paper, on which I was writing, had the same yellowish-white hue as the heavens. The fowls showed that peculiar restlessness that was remarked in them during the total eclipse of the sun in 1806. Some of them retired to roost. The cocks crowed several hours incessantly, as they do at the dawning of day.

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* From the *Memoirs of the American Academy of Arts and Sciences*, vol. iv part. ii. p. 393. Cambridge 1821.

At 3 P. M. the sky brightened up a little, but in the evening the darkness became more extraordinary. A person could not discern his hand, held directly before his eyes. It was next to impossible for a person to find his way even in streets where he had been long accustomed to walk.

The sun was concealed from our view, nearly the whole time, from Monday evening to Friday morning. It did occasionally appear, but was always of a deep blood-red colour; and the apparent magnitude was at least one-third larger than usual. This was very striking on Friday, about nine in the morning. A dense, yellow vapour was then passing slowly over its enlarged disc. The spectacle was viewed by many with astonishment.

The darkness was not confined to this immediate vicinity It was as great seventy miles west (in the State of New York) as at this place. And here I beg leave to insert an extract of a letter, on this subject, from Noadiah Moore, Esq. of Champlain, N. Y. a well informed and highly respectable gentleman.

" The darkness was first noticed on the night of the 6th November, when the day closing with a hazy atmosphere, the night became so exceedingly dark as to render the sense of sight wholly useless. The horse and his rider were in equal uncertainty. The moon, though near the full, produced no sensible change as it rose. Even the faint *profile* of the landscape, so important a guide to the benighted traveller, was lost in intense obscurity. The atmosphere continued to be clouded by dense vapours until the 9th; when the darkness greatly increased. A light snow covered the ground. It blew a strong gale from the south. The clouds, from which fine drops of rain were continually descending, resembled the pitchy blackness of the smoke of a furnace; they moved in a wild and hurried manner through the heavens; and, at times, seemed to be closing down upon the earth. Several claps of distant thunder were heard, and in a town adjoining, a heavy shower ensued.

"The water caught in this shower was observed to be much discoloured. A quantity caught in a clean vessel, exposed in a situation where it fell directly from the heavens, was preserved for many days in a corked phial, and did not wholly deposit its colouring matter. In appearance it was not unlike water impregnated with soot. As to the degree of darkness which prevailed, it may be observed, that writing, reading, or needlework could not be properly performed without candles. Indeed, candles were used during most of the day in many of the houses and workshops. Towards evening it brightened up a little, but night brought darkness tangible."

The darkness was observed throughout the northern portion of this State, and in several parts of Canada. At Montpelier, about forty miles north-east of this place, it is said to have been greater than it was here. A gentleman, from that town, informed me that the darkness there was so great, that the speaker of the House of Representatives could not distinguish the countenances of the members, so as to determine who was addressing him. The same gentleman added, that where he stopped to dine, he was obliged to make use of a candle to distinguish the different kinds of food which were placed before him.

In the small quantity of water which fell from the atmosphere, I did not observe any extraordinary colour, or smell, or taste. It is stated in *Le Courier du Bas-Canada*, "that the water was of a black colour, as if it had been impregnated with a large proportion of soot; and several persons who had tasted it, discovered the taste of soot. This colour the water retained a considerable time." I have read remarks of a similar kind in the newspapers from various parts of New England. Had the fall of water here been more copious, I should probably have noticed the peculiarity above described.

The appearance of the heavens during the late period of darkness, was very much like that which is frequently occasioned by extensive fires in the woods. An effect, similar in kind, but far inferior in degree, was produced a few years since, by the fires which raged several weeks, and consumed most of the underwood on the Green Mountains opposite this place. The darkness observed at that time was very considerable, and the sky was of a pale yellowish-red aspect.

The cause assigned by Dr Williams [*], for the uncommon darkness of 1780, is perhaps the most satisfactory which could be given. But in the present case, no similar cause can be supposed, at least in New England. No great fires were destroying our woodlands. It was too late in the season. The combustible matter of the forests was not sufficiently dry.

The darkness of 1780 occurred in May, after a long period of dry weather; that of 1819 in November, without being preceded by any unusual drought, especially in this part of the country. The former lasted only thirteen or fourteen hours; the latter nearly a week.

The cause of this phenomenon, whatever it may be, is undoubtedly to be sought at a considerable distance to the south of New England. Many persons in this vicinity, as well as myself, observed, that when the wind blew most powerfully from a southerly quarter, it brought with it a vast quantity of smoke, or of something much resembling it; and that the sky was then the darkest; that when the wind shifted, and blew a short time in any other direction, the atmosphere was in a degree cleared of this smoky matter. During the time the darkness lasted, there was for the most part a pretty strong wind from the south. On Friday morning it changed to the west, and continued to blow for some time from that quarter. The unusual obscurity gradually disappeared, and objects, both in the heavens and upon the earth, soon assumed their ordinary aspect.

Since writing the above, I have seen an article in the "Missionary," of the 12th of November—a very respectable paper—printed at Mount Zion, Hancock Co. Georgia, relating to this phenomenon. It is stated, that "the atmosphere had been very smoky for about a fortnight preceding; so much so, that it had literally intercepted the rays of the sun at noon during a part of this time, and seriously affected the eyes." "It is doubtless," added the writer, "occasioned by great fires in the Indian territories. The wind has blown almost invariably from that direction for some time.

That the late darkness had its origin in some of our most southern states, or in the territories belonging to them, can, I think, hardly be questioned. It is by no means improbable that it was occasioned by fires, running on those immense *prairies* that furnish annually such vast quantities of combustible materials. We are told that these prairies "are covered with a coarse kind of grass, which, before the country is settled in their vicinity, grows to the height of six or seven feet [*]." This vegetation, another writer observes, "becomes sufficiently dry to burn during the long dry season, called the *Indian Summer*; which commences usually in October, and continues a month and a half or two months, during which the vegetation is killed by the frost, and dried by the sun; the wet prairies are also dried, and before the season has expired, the grass is perfectly combustible [†]." In order the more easily to take their game, and to facilitate travelling from one hunting ground to another, the Indians, we are informed, occasionally set fire to the prairies "towards the close of the Indian summer."

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[*] *Memoirs of the Amer. Acad.* vol. i p. 234.

ART. X.—*Account of a Map by a Slave to the Heir-apparent of Ava*. By FRANCIS HAMILTON, M. D. F. R. S. Lond. & Edin., and F. A. S. L. & E. Communicated by the Author.

THIS Map (Plate IX.) contains the Mranma territory between Pre or Prin, and Taunu on the south, and Amarapura on the north. It is evident, that no scale can be adapted for this map, as the five days' journey between Pre and Taunu are longer than the six days' between the latter and Taunduængri; and the seventeen leagues between Taunu and Mrolla, are much longer than the thirty-seven leagues between the latter and Gnaunduæn. The reason, perhaps, of these inaccuracies was, that in these southern parts, the composer had no places of consequence to fill up the space, and, therefore, did not proceed from stage to stage, taking room for each, as in the more occupied parts towards the north.

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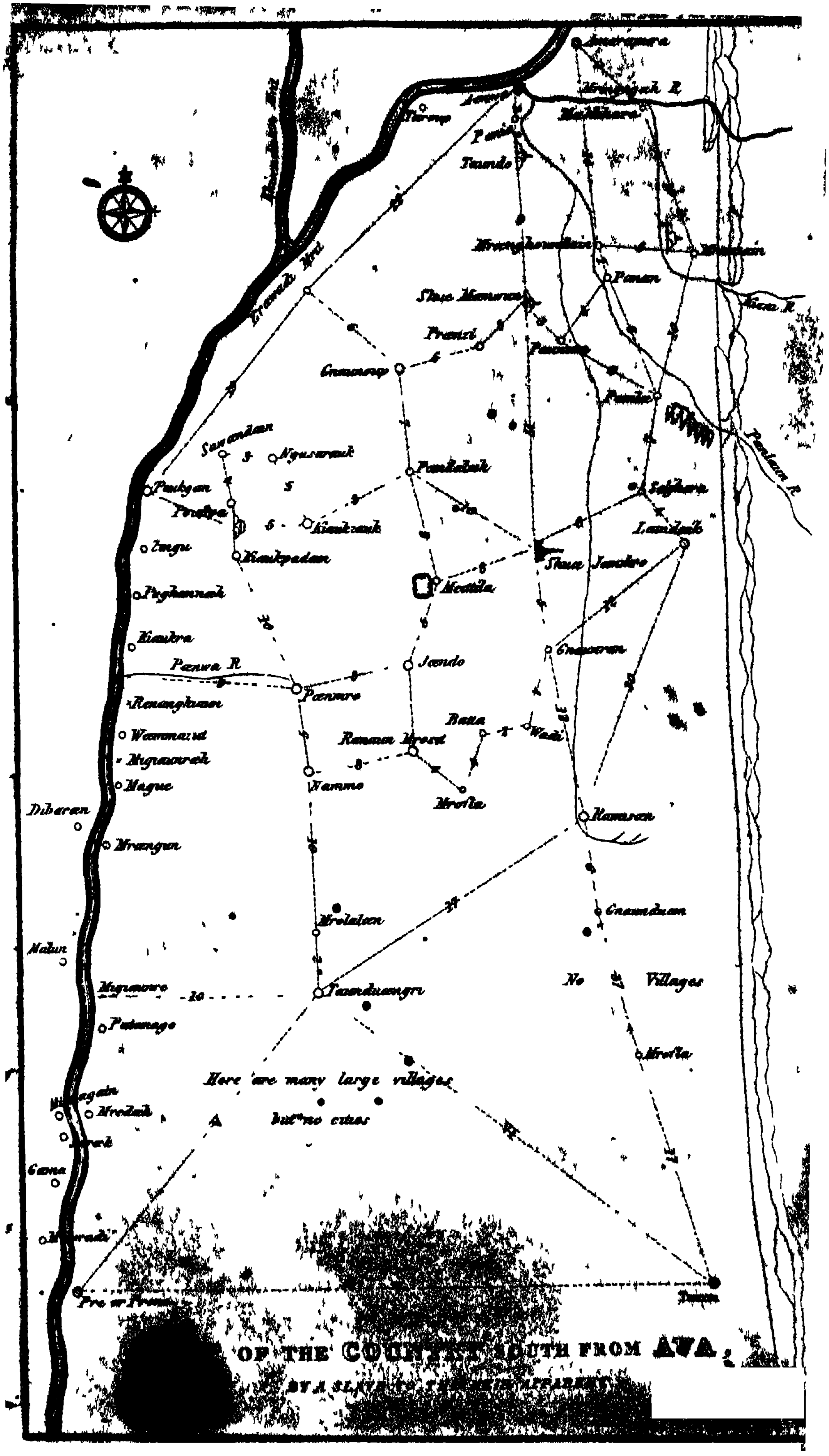
[*] See Atwater's Letters to Professor Silliman on the Prairies of the West, published in *The American Journal of Science*, vol. i. p. 116.

[†] See R. W. Wells's communication on Prairies, published in the same work, vol. i. p. 331.



OF THE COUNTRY SOUTH FROM AVA,

BY A SLAVE TO THE HEIR APPARENT.

In this map Migiaunræh is placed to the north of Patanago; but, in passing both up and down, the place called to me Patanago was farthest north. This may have arisen from my having transposed the names in copying, otherwise it would render us more doubtful of the general accuracy of the map.

In this map, the capitals of principalities are marked by a double circle, the chief places of governments by circles, and places dependent on the latter by crosses, or by circles round a cross. These dependent places, however, are often larger than the seat of Government, on which they depend. Migiaunræh, for instance, is a place of great trade, and more populous than Patanago, on which it depends, although the latter is a pretty considerable town.

The most valuable part of this map should, no doubt, have been the distances given between various places; but, unfortunately, on examination, I find, that very great mistakes must be here admitted. For, we may observe, that from Amarapura to Paukkan (Pagalun Mew of Arrowsmith), the map gives 44 leagues, or 96¼ British miles road distance, while Arrowsmith's map gives 90 geographical miles direct distance, so that the computed distance on this part of the map falls short of the real measurement. In another route the computed league is evidently vastly longer, as between Migiaunræh and Ramisæn, this map makes only 27 leagues; while the map by the native of Taunu makes the distance from the latter to Patanago, close to the former, six days' journey, or 60 leagues. It is true, that in the latter map I have found the day's journey on long routes to give only 17 geographical miles direct distance; while, in the map now under consideration, the measured distance between Amarapura and Paukkan gives nearly 21 geographical miles. Even this allowance, however, would by no means reconcile the two accounts; and some error in the distance between Magiaunræh and Ramisæn in this map, is evident: for the route between Amarapura and Taunu being nearly parallel with the Erawadi, north from Prin or Pre, both running nearly north and south for a considerable way, the distance from the towns on the Erawadi, such as Migiaunræh, to the great inland road, in the direction of east and west, must be nearly the same with the distance between Pre and Taunu, that is about 14 geographical miles in a direct line; and as Ramisæn is no doubt considerably to the north of Migiaunræh, the distance, from the obliquity of its course, must be considerably more. These errors render the whole distances in this map doubtful; yet a great many of them coincide tolerably with those given in the map by the native of Taunu. For instance, Taunu in both, is five days' journey from Pre. On the whole, however, most reliance is to be placed on those given by the native of Taunu, when there is a difference. When both coincide, it adds to our confidence.

The mountains of the Shanwas in this map are represented by a chain, running in a straight line, north a little westerly, past Taunu and Amarapura; and the chain has a considerable resemblance to mountains, as seen from a distant plain, and as these hills appear from the Mranma country; but there is great reason to think, that the delineation by the native of Taunu, although very rude, gives a more accurate knowledge, and represents the Shanwa country as mountainous, with hills running in all directions, and among these numerous valleys, which are occupied by many towns, and which, I understand, are finely watered, and very productive. It might be imagined, that the western limit of this country formed a straight line, as represented in this map; but the map by the native of Taunu represents the hilly region as extending first NE. towards Gnaunrue, and then NW. towards Ava; so that the courses of the Panlaun and Paunlaun rivers are entirely through the plain of the Mranma territory. Although this, when compared with the Shanwa country, may be called a plain, yet it is by no means a flat like Bengal, but contains many small ridges, and little detached hills, some of which are neatly enough represented in the slave's map; but the greater part is more carefully delineated, with respect to number and extent, in the rude performance of the native of Taunu.

In the slave's map, the Mringngæh river and its branches are much better delineated than in the map by the native of Taunu; but the Paunlaun is left out, as no part of its course could be included, except a small portion near Taunu. On this account, probably, even its branches have been altogether omitted, although several of them pass through the country here delineated.

A torrent called Pænwa, not connected with these branches of the Paunlaun, and omitted by the native of Taunu, has been laid down in this map. It rises near a town called Pæn, and, on the 6th of November, when I was at its mouth, I found it nearly dry. The people on the spot called it Pænghiaun, or the Pæn Torrent, and gave the name Pænwa to a small town at its mouth, which serves as a port for the trade of Præn Mro, the city at its source.

Art. XI.—*New Inquiries into the Laws which are observed in the Distribution of Vegetable Forms.* By Baron Alexander Humboldt [*].

The numerical proportions of vegetable forms may be viewed in two perfectly distinct lights. If we consider plants, grouped together in natural families, without having regard to their geographical distribution, we enquire what are the types of organization, according to which the greatest number of species are formed. Are there more Glumaceæ than Compositæ on the globe? Do these two tribes of vegetables constitute together the fourth part of Phænogamous plants? What is the proportion of Monocotyledones to the Dicotyledones? These are questions of general Phytology—of the sciences which examine the organization and mutual connection of vegetables. If we view the species which we associate according to the analogy of their form, not in an abstract manner, but with regard to their climacteric relations, or their distribution over the surface of the globe, the questions which arise afford an interest highly varied. What are the families of plants which predominate over the other phænogamous vegetables more within the torrid zone than under the polar circle? Are the Compositæ more numerous, either in the same geographical latitude, or on the same isothermal band, in the new Continent than in the old? Do the types which predominate less in advancing from the equator to the pole, follow the same law of decrease, in proportion as they rise toward the summit of the equatorial mountains? Do not the mutual proportions of families vary, on isothermal lines of the same denomination, in the temperate zones, to the north and to the south of the equator? These questions belong to the geography of plants, properly so called: they are connected with the most important problems belonging to meteorology and the natural history of the globe in general. Upon the preponderance of certain families of plants, depends also the character of the landscape, the aspect of a country, whether of a beautiful or majestic nature. The abundance of the Gramineæ, which form vast savannahs, and that of the Palms or the Coniferæ, are much influenced by the social state of the people, by their manners, and by the more or less perfect development of the economical arts.

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[*] A separate copy of this memoir was sent to us by the author for insertion in our Journal, through Dr Marcet.

In considering the geographical distribution of forms, we may attend to species, to genera, and to natural families, (Humboldt, *Proleg. in Nov. Pen.* vol. i. pp. xiii. li. & 33.). Often a single species of plants, especially among those which I have named *social* plants, covers a vast extent of country. Of this kind, in the north, are the heaths and forests of pines; in equinoctial America, the associations of Cactus, Croton, Bambusa, and Brathys of the same species. It is curious to examine the proportions of organic multiplication and development. We may demand what species in a given zone produces the greatest number of individuals;—we may point out the families to which in different climates belong the species which predominates over the others. Our imagination is peculiarly struck with the preponderance of certain plants, which we consider, on account of their easy reproduction, and the great number of individuals which present the same specific characters, as the more common plants of this or that zone. In a northern region, where the Compositæ and the Ferns are to the phænogamous plants in the proportion of 1 : 13, and of 1 : 25, (that is to say, where we find these proportions on dividing the total number of the phænogamous plants by the number of the species of the Compositæ and Ferns,) a single species of Fern may occupy ten times as much space as the whole species of Compositæ together. In this case, the Ferns predominate over the Compositæ by the mass,—by the number of *individuals* belonging to the same species of Pteris or of Polypodium; but they do not predominate, if we compare with the total sum of the species of phænogamous plants the different forms which compose the two groups of Ferns and Compositæ. As the multiplication of all the species does not follow the same laws, since they do not all produce the same number of individuals, the quotient obtained in dividing the total number of phænogamous plants by the number of species of different families, does not of itself decide the aspect, I might almost say kind of monotony of nature in the different regions of the globe. If the traveller is struck with the frequent repetition of the same species,—with the sight of those which predominate by their mass,—he is not less so with the paucity of individuals of some other species useful to man. In the countries where the Rubiaceæ, the Leguminosæ, or the Terebinthaceæ, compose the forests, we are surprised to see how rare are the trees of certain species of Cinchona, Hæmatoxylon, and the Balsamiferæ.

In turning our attention to species, we may also, without having regard to their multiplication, and to the greater or smaller number of individuals, compare in each zone, in an absolute manner, the species which belong to different families. This interesting comparison has been made in the great work of M. Decandolle, (*Regni Vegetabilis Systema Naturæ,* vol. i. p. 128. 396. 439. 464. 510.). M. Kunth has attempted it with more than 3300 Compositæ already known up to the present day, (*Nova Genera,* vol. iv. p. 238.) It does not point out what family predominates in the same degree above the other indigenous phænogamous plants, either by the mass of individuals, or by the number of species; but it presents the numerical proportions between the species of the same family belonging to a different country. The results of this method are generally more precise, because they are obtained without valuing the total mass of phænogamous plants, after being freed with care from the study of each isolated family. The forms which are the most varied, the Ferns, for example, are found under the tropics: it is in the mountainous, temperate, humid and shady parts of the equatorial regions, that the family of Ferns produces the greatest number of species. In the temperate zone, there are not so many as under the tropics: their absolute number still diminishes as we advance toward the pole; but since the cold region, for example Lapland, produces species of Ferns which resist the cold better than the great mass of phænogamous plants, the Ferns, by the number of species, predominate more over the other plants in Lapland than in France or Germany. The numerical proportions presented in the table which I have published in my *Prolegomena de Distributione Geographica Plantarum*, and which appears again here perfected by the great labours of Mr Robert Brown, differ entirely from the proportions given by an absolute comparison of the species which grow in the different zones. The variation which we observe in proceeding from the equator to the poles is not consequently the same in the result of the two methods. In this, two of the fractions used by Mr Brown and myself are variable, since, in changing the latitude, or rather the isothermal zone, the total number of phænogamous plants is not seen to vary in the same proportion as the number of species which constitute the same family.

When from *species* or *individuals* of the same form which are reproduced according to constant laws, we pass to divisions of the *natural method*, we may turn our attention to genera, to families, or to sections still more general. There are some genera and some families which belong exclusively to certain zones, to a particular association of climacteric conditions; but there is a great number of genera and of families which have representatives in all zones, and at all heights. The first researches which have been made regarding the geographical distribution of forms, those of M. Treviranus, published in his ingenious work on Biology, (vol. ii. p. 47. 63. 83. 129.), have for their object the dispersion of genera over the globe. That method is less proper for presenting general results than this, which compares the number of species of each family, or the large groups of the same family, with the total mass of phænogamous plants. In the frigid zone, the variety of generic forms does not diminish in the same degree as the variety of species: we find more genera, with a smaller number of species, (Decandolle, *Théorie Elément.* p. 190.; Humboldt, *Nova Gen.* vol. i. p. xvii. & l.): It is nearly the same on the summit of the lofty mountains, which receive colonists of a great number of genera, which we suppose to belong exclusively to the vegetation of the plains.

I have deemed it necessary to show the different points of view from which the laws of the distribution of vegetables may be seen. It is in confounding them that we think the contradictions are to be found, which are not otherwise than apparent, and which are erroneously attributed to the uncertainty of observations. (*Berliner Jährbücher der Gewächskunde*, Bd. i. p. 18. 21. 30.) When the following expressions are used: "this form or this family loses itself toward the frigid zone;" "it has its true native country in such and such a parallel;" "it is a southern form;" "it abounds in the temperate zone;" we must expressly mention, if we consider the absolute number of species, the increase or decrease of their absolute frequency with the latitudes, or if we speak of families which predominate in the same degree over the rest of the phænogamous plants. These expressions are correct: they afford a precise signification, if we distinguish the different methods according to which we consider the variety of forms. The Island of Cuba (to use an analogous case taken from political economy) contains a much greater number of individuals of the African than of the Martinique race; and yet the mass of these individuals predominates much more over the number of whites in this latter island than in that of Cuba

The rapid progress which the geography of plants has made within these twelve years, by the united labours of Messrs Brown, Wahlenberg, Decandolle, Leopold de Buch, Parrot, Ramond, Schouw and Hornemann, are owing in a great measure to the advantages of the natural method of M de Jussieu. In following, I shall not say the artificial classifications of the sexual system, but the families founded upon vague and erroneous principles, (*Dumosæ, Corydales, Oleraceæ,*) we no longer perceive the great physical laws in the distribution of vegetables on the globe. It was Mr Robert Brown, who, in a celebrated memoir on the vegetation of New Holland, first made known the true proportions between the great divisions of the vegetable kingdom, the Acotyledonous, Monocotyledonous, and Dicotyledonous plants. (Brown, in *Flinders' Voyage to Terra*

Australis, vol. ii. p. 538; and *Observations systematic and geographical on the Herbaries of the Congo*, p. 3.) I made an attempt, in 1815, to pursue this kind of research, in extending it to the different orders or natural families. The natural history of the globe is, in its numerical elements, like the system of the world, and can be brought to perfection only by the joint efforts of botanical travellers, to discover the true laws of the distribution of vegetables. The collection of facts is not of itself sufficient: in order to obtain the most accurate approximations, (and we do not pretend to give any thing but approximations,) the different circumstances under which the observations have been made must be discussed. I think with Mr Brown, that we ought to prefer in general to calculations made upon incomplete lists of all the plants published, the examples taken from countries of considerable extent, and whose Flora is well known, such as France, England, Germany, and Lapland. It would be desirable to have still a complete Flora of two countries of 20,000 square leagues, destitute of lofty mountains and of platforms, and situated between the tropics in the Old and in the New Worlds. Until this shall be accomplished, we must be contented with the great herbaries formed by travellers, who have resided for some time in the two hemispheres. The habitations of plants are so vaguely and incorrectly pointed out, in the vast compilations known under the names of *Systema Vegetabilium*, and *Species Plantarum*, that it would be very dangerous to use them in an absolute manner. I have not employed these lists otherwise than in a subsidiary manner, to control and modify a little the results obtained by the Floras and the partial herbaries. The number of equinoctial plants which M. Bonpland and I have brought to Europe, and of which our learned colleague M. Kunth will have soon finished the publication, is perhaps numerically greater than any of the herbaries formed between the tropics; but it is composed of the vegetables of the plains and elevated platforms of the Andes. The alpine plants are even much more considerable than in the Floras of France, of England, and of the Indies, which associate also the productions of different climates belonging to the same latitude. In France, the number of species which vegetate exclusively at above 500 toises of height, does not appear to be more than $\frac{1}{7}$th of the entire mass of phænogamous plants. (Decandolle, in the *Mem. de Arcueil*, vol. iii. p. 295.).

It will be useful to consider at a future period the vegetation of the tropics and that of the temperate region between the parallels of 40° and 50°, according to two different methods, either in searching the numerical proportions in the whole of the plains and the mountains, which nature presents over a great extent of country, or in determining these proportions in the plains alone of the temperate zone and of the torrid zone. As our herbaries are the only ones that point out, according to barometrical measurement, in more than 4000 plants of the equinoctial region, the height of each station above the level of the sea, the numerical proportions of the table which I have already published may be rectified, when our work, the *Nova Genera*, shall be finished, by taking away from the 4000 phænogamous plants which M. Kunth has employed in this work (*Prolegom.* p. 16.), the plants which grow at above 1000 toises, and by dividing the total number of plants which are not alpine, of each family, by that of plants which live in the cold and temperate regions of equinoctial America. This mode of proceeding should affect more, as we shall show by and bye, the families which abound in alpine species, for example, the Gramineæ and the Compositæ. At 1000 toises of elevation, the mean temperature of the air is still, on the back of the equatorial Andes, 17° centigr., which is equal to that of the month of July at Paris. Although on the platform of the Cordilleras, we find the same annual temperature as in the high latitudes, (because the *isothermal line* of 8°, for example, is the track marked in the plains by the intersection of the *isothermal surface* of 8°, with the surface of the earth's spheroid,) it is not too much to generalise these analogies of the temperate climates of the equatorial mountains, with the low regions of the circumpolar zone. These analogies are not so great as might be thought: they are modified by the influence of the partial distribution of the heat in the different parts of the year. (*Prolég.* p. 54., and my *Mémoire sur les Lignes Isothermes* *, p. 137.) The quotients do

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* A translation of this valuable Memoir will be found in this *Journal*, vol. III. pp. 1, 256.; IV. pp. 23, 262.; V. p. 28.

not change, however, in ascending from the plains toward the mountains, in the same manner as they change in approaching the pole: this is the case with the Monocotyledones, considered in a general view, as well as with the Ferns and Compositæ. (*Prolcg.* p. 51. and 52.; Brown on *Congo*, p. 5.)

It may further be remarked, that the development of vegetables of different families, and the distribution of forms, depend not on isothermal latitudes, nor on geographical latitudes alone; but that the quotients are not always similar on the same isothermal line of the temperate zone, in the plains of America and of the Old Continent. There exists, under the tropics, a very remarkable difference between America, India, and the west coasts of Africa. The distribution of organic beings on the globe, depends not only on very complicated climatic circumstances, but also on geological causes, with which we are entirely unacquainted, because they are connected with the original state of our planet. The great Pachydermata are wanting at the present day in the New World, although we find them still in abundance in analogous climates, in Africa, and in Asia. In the equinoctial zone of Africa, the family of palms is far from numerous, compared with the great number of species of equinoctial America. These differences, far from deterring us from the scrutiny of the laws of nature, ought to excite us to study these laws in all their complications. The lines of equal heat are not parallel to the equator. They have, as I have tried to prove elsewhere, convex summits, and concave summits, which are distributed with great regularity over the globe, and form different systems along the eastern and western coasts of the two worlds, in the centre of continents, and in the neighbourhood of the ocean. It is probable, that when philosophical botanists have travelled over a larger extent of the globe, we shall find, that often the lines of the *maxima* of *agroupment* (the lines taken from the points where the fractions are reduced to the smallest denominator,) become isothermal lines. In dividing the globe by longitudinal bands comprehended between two meridians, and in comparing the numerical proportions under the same isothermal latitudes, we perceive the existence of different systems of *agroupment.* We can already, with the actual state of our knowledge, distinguish four systems of vegetation, those of the New Continent, of Western Africa, of India, and of New Holland. Since, notwithstanding the regular increase of the mean heat from the pole to the equator, the *maximum* of heat is not identical in the different regions at different degrees of longitude, there exist also places where certain families attain a more perfect development than at any other: this is the case with the family of Compositæ in the temperate region of North America, and especially at the southern extremity of Africa These partial accumulations determine the physiognomy of the vegetation, and are what we call vaguely the characteristic features of the landscape.

In the whole temperate zone, the Glumaceæ and Compositæ form together more than the fourth part of the phænogamous plants. We find, from the same inquiries, that the forms of organised beings have a mutual dependence. The unity of nature is such, that the forms are universally limited according to constant and immutable laws. When we know at any point of the globe the number of species which a great family presents, (for example, that of the Glumaceæ, the Compositæ, or the Leguminosæ,) we can estimate with much probability both the total number of phænogamous plants, and the number of species which compose the other vegetable families. It is thus, that, on knowing the number of Cyperaceæ or of Compositæ in the temperate zone, we can form an estimate of that of the Gramineæ or Leguminosæ. These estimates enable us to see in what tribes of vegetables the Floras of a country are still deficient: they are so far from being uncertain, as to enable us to avoid confounding the quotients which belong to the different systems of vegetables. The labour which I have bestowed upon plants, will no doubt one day be applied with success to the different classes of vertebral animals. In the temperate zones, there are nearly five times as many birds as mammalia, and the latter increase much less toward the equator than the birds and reptiles.

The geography of plants may be considered as a part of the natural history of the globe. If the laws which nature has followed in the distribution of vegetable forms, should prove to be more complicated than they appear at first sight, still, we ought not on this account to be deterred from submitting them to accurate investigation. We do not relinquish the tracing of a map, when we perceive the sinuosities of rivers, and the irregular form of coasts. The laws of magnetism become intelligible to him who has commenced with tracing the lines of equal inclination and declination, and who has compared a great number of observations, which, at first sight, might seem contradictory. He who thinks that it is not yet time to search the *numerical elements* of the geography of plants, forgets the progressive march by which the physical sciences have elevated themselves to determinate results. In examining a complicated phenomenon, we commence with a general scrutiny of the circumstances by which it is determined or modified; but, before discovering certain proportions, we find, that the first results to which we attend, are not sufficiently free from local influence: it is then that we modify and correct the numerical elements, and discover the regularity in the very effects of partial disturbances. Criticism exercises itself on whatever has been prematurely announced as a general result; and the spirit of criticism once excited, becomes favourable to the investigation of truth, and accelerates the progress of human knowledge.

ACOTYLEDONES. Cryptogamous plants (fungi, lichens, mosses, and ferns); *Agames celluleuses et vasculaires* of M. Decandolle. On uniting the plants of the plains with those of the mountains, we have found them to be under the tropics $\frac{1}{9}$; but their number ought to be much greater. Mr Brown has rendered it very probable, that, in the torrid zone, the proportion is in the plains $\frac{1}{15}$, on the mountains $\frac{1}{5}$ *. (*Congo*, p. 5.) In the temperate zone, the agamous plants are generally to the phænogamous as 1 : 2; in the frigid zone they attain the same number, and often exceed it considerably.

On dividing the agamous plants into three groups, we observe that the ferns are more frequent (the denominator of the fraction being less) in the frigid zone than in the temperate zone, (*Berl. Jahrb.*, bd. i. p. 32.), and the lichens and mosses also increase towards the frigid zone. The geographical distribution of ferns depends upon the union of the local circumstances of shade, humidity, and moderate heat. Their *maximum* (that is to say, the place where the denominator of the normal fraction of a group becomes the least possible,) is found in the mountainous parts of the tropics, particularly in islands of small extent, where the proportion rises to $\frac{1}{3}$, and upwards. When the plains and mountains were not separated, Mr Brown found the ferns of the torrid zone to be $\frac{1}{20}$. In Arabia, India, New Holland, and Western Africa, (between the tropics,) they are $\frac{1}{26}$: our herbaries of America do not give more than $\frac{1}{36}$; but the ferns are rare in the great valleys and on the dry platforms of the Andes, where we were forced to remain a long time. (*Congo*, p. 43., and *Novagen.*, vol. i. p. 33.) In the temperate zone, the ferns are $\frac{1}{70}$; in France, $\frac{1}{73}$; in Germany, according to late inquiries, $\frac{1}{71}$. (*Berl. Jahrb.*, b. i. p. 26.) The group of ferns is extremely rare on the Atlas mountains, and almost completely disappears in Egypt. In the frigid zone, the ferns appear to rise to $\frac{1}{25}$.

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* In this article, the fractions $\frac{1}{9}$, $\frac{1}{15}$, $\frac{1}{5}$, indicate the proportions between the species of a family and the total number of Phænogamous plants which vegetate in the same country. The abbreviations *Trop. Temp. Frig.*, signify *Tropics or Torrid Zone, Temperate Zone, Frigid Zone.*

Monocotyledones. The denominator becomes progressively smaller in proceeding from the equator toward the 62d degree of North Latitude; it increases again in the regions still farther north, on the coast of Greenland, where the Gramineæ are very scanty. (*Congo*, p. 10.) In the different parts of the tropics, the proportion varies from $\frac{1}{5}$ to $\frac{1}{6}$. In 3880 phænogamous plants of equinoctial America, found by M. Bonpland and me, in flower and in fruit, there are 654 monoctyledonous, and 3226 dicotyledonous: hence the great division of the Monocotyledones would be $\frac{1}{6}$ of the phænogamous plants. According to Mr Brown, the proportion in the Old Continent (in India, equinoctial Africa, and New Holland,) is $\frac{1}{5}$; in the temperate zone we find $\frac{1}{4}$. (France, $1:4\frac{3}{5}$; Germany, $1:4\frac{1}{2}$; North America, according to Pursh, $1:4\frac{1}{2}$; Kingdom of Naples, $1:4\frac{1}{5}$; Switzerland, $1:4\frac{1}{4}$; British Isles. $1:3\frac{5}{7}$): in the frigid zone, $\frac{1}{3}$.

Glumaceæ. (The three families of Junceæ, Cyperaceæ, and Gramineæ, united). = Trop., $\frac{1}{11}$. Temp., $\frac{1}{8}$. Frig., $\frac{1}{4}$.

The increase toward the north is owing to the Junceæ and Cyperaceæ being very rare compared with the other Phænogamous plants, in the temperate and torrid zones. On comparing the species belonging to the three families, we find that the Gramineæ, the Cyperaceæ, and the Junceæ, are under the tropics, as 25, 7, 1; in the temperate region of the Old Continent, as 7, 5, 1; in the polar circle, as $2\frac{2}{5}$, $2\frac{3}{5}$, 1. In Lapland the Gramineæ and Cyperaceæ are equal: toward the equator the Cyperaceæ and Junceæ diminish much more than the Gramineæ; the junceal form disappears almost entirely under the tropics, (*Nova Gen.* vol. i. p. 240.).

JUNCEÆ alone. =Trop., $\frac{1}{400}$. Temp., $\frac{1}{90}$. Frig., $\frac{1}{25}$, (Germany, $\frac{1}{94}$; France, $\frac{1}{86}$.)

CYPERACEÆ alone. =Trop. America, nearly $\frac{1}{57}$; Western Africa, $\frac{1}{18}$; India, $\frac{1}{25}$; New Holland, $\frac{1}{14}$. (*Congo*, p. 9). Temp., probably $\frac{1}{20}$. (Germany, $\frac{1}{16}$; France, according to the works of M. Decandolle, $\frac{1}{27}$; Denmark, $\frac{1}{16}$.) Frig. $\frac{1}{9}$. This is the proportion found in Lapland, and as far as Kamtschatka.

GRAMINEÆ alone. Trop. I have allowed as much as $\frac{1}{15}$. Mr Brown found in Western Africa, $\frac{1}{12}$; in India, $\frac{1}{12}$. (*Congo*, p. 41.) M. Hornemann fixed this part of Africa at $\frac{1}{10}$. (*De Indole Plant. Guineensium*, 1819, p. 10.) Temp. Germany, $\frac{1}{13}$; France, $\frac{1}{13}$. Frig. $\frac{1}{10}$.

COMPOSITÆ. On blending the plants of the plains with those of the mountains, we have found in equinoctial America $\frac{1}{6}$ and $\frac{1}{7}$; but, of 534 Compositæ of our herbaries, there are only 94 which grow to 500 toises above the plains, (the height at which the mean temperature is still 21°.8; equal to that of Cairo, of Algiers, and of the Island of Madeira.) From the equatorial plains to 1000 toises of height (where we have still the mean temperature of Naples), we have collected 265 Compositæ. This last result gives the proportion of Compositæ, in the regions of equinoctial America, beneath 1000 toises, from $\frac{1}{5}$ to $\frac{1}{10}$. This result is very remarkable, because it proves, that between the tropics in the lowest and warmest region of the New Continent, there are fewer Compositæ, in the subalpine and temperate regions more, than under the same circumstances in the Old World. Mr Brown found on the Rio-Congo, and in Sierra-Leone, $\frac{1}{25}$; in India and New Holland $\frac{1}{18}$. (*Congo*, p. 26; *Nova Gen.* vol. iv. p. 239.) In the temperate zone, the Compositæ are in America, $\frac{1}{6}$, (this is probably also in equinoctial America the proportion of the Compositæ of the highest mountains to the whole mass of alpine phænogamous plants); at the Cape of Good Hope, $\frac{1}{5}$; in France, $\frac{1}{7}$ (correctly $\frac{2}{15}$); in Germany $\frac{1}{8}$ Under the frigid zone the Compositæ are, in Lapland, $\frac{1}{13}$; in Kamtschatka, $\frac{1}{13}$. (*Hornemann*, p. 18.; *Berl. Jahrb.* b. i. p. 29.)

Leguminosæ. = Trop. America, $\frac{1}{12}$; India, $\frac{1}{4}$; New Holland, $\frac{1}{4}$; Western Africa, $\frac{1}{5}$, (*Congo*, p. 10.) Temp. France, $\frac{1}{16}$; Germany, $\frac{1}{26}$, North America, $\frac{1}{19}$; Siberia, $\frac{1}{11}$, (*Berl. Jahrb.* b. i. p. 22.) Frig. $\frac{1}{35}$.

Labiatæ. = Trop. $\frac{1}{40}$. Temp. North America, $\frac{1}{40}$; Germany, $\frac{1}{26}$; France, $\frac{1}{24}$. Frig. $\frac{1}{70}$. The rarity of Labiatæ and Cruciferæ in the temperate zone of the New Continent is a very remarkable phenomenon.

Malvaceæ. = Trop. America, $\frac{1}{40}$; India and Western Africa, $\frac{1}{34}$, (*Congo*, p. 9.); on the coast of Guinea alone, $\frac{1}{20}$, (*Hornemann*, p. 20.) Temp. $\frac{1}{200}$. Frig. 0.

Cruciferæ. Almost wanting under the tropics, on taking away the mountains to within from 1200 to 1700 toises (*Nova Gen.* p. 16.) France, $\frac{1}{19}$; Germany, $\frac{1}{18}$; North America, $\frac{1}{62}$.

Rubiaceæ. Without dividing the family into sections, we find beneath the tropics, in America, $\frac{1}{29}$; in Western Africa, $\frac{1}{14}$: under the temperate zone in Germany, $\frac{1}{70}$; in France, $\frac{1}{73}$: under the frigid zone, in Lapland, $\frac{1}{80}$. Mr Brown separates the great family of Rubiaceæ into two groups, which present very distinct climatic proportions. The group of Stellatæ without interposed stipules, belong chiefly to the temperate zone: it almost disappears between the tropics, excepting at the summit of the mountains. The group of Rubiaceæ with opposite leaves and stipules, belong very peculiarly to the equinoctial region. M. Kunth has divided the great family of Rubiaceæ into eight groups, one of which, that of the Coffeaceæ, forms in our herbaries a third part of the whole Rubiaceæ of equinoctial America. (*Nov. Gen.* vol. iii. p. 341.)

EUPHORBIACEÆ. = Trop. America, $\frac{1}{33}$; India and New Holland, $\frac{1}{30}$; Western Africa, $\frac{1}{28}$. (*Congo*, p. 25.) Temp. France, $\frac{1}{70}$; Germany, $\frac{1}{100}$. Frig. Lapland, $\frac{1}{500}$.

ERICEÆ and RHODODENDRA. = Trop. America, $\frac{1}{130}$. Temp. France, $\frac{1}{125}$; Germany, $\frac{1}{90}$; North America, $\frac{1}{30}$. Frig. Lapland, $\frac{1}{25}$.

AMENTACEÆ. = Trop. America, $\frac{1}{800}$. Temp. France, $\frac{1}{50}$; Germany, $\frac{1}{40}$; North America, $\frac{1}{25}$. Frig. Lapland, $\frac{1}{20}$.

UMBELLIFERÆ. = almost none under the tropics to the height of 1200 toises; but, on taking both the plains and high mountains in equinoctial America, $\frac{1}{100}$; under the temperate zone much more numerous in the Old than in the New Continent. France, $\frac{1}{34}$; North America, $\frac{1}{57}$; Lapland, $\frac{1}{60}$.

On comparing the two worlds, we find in general in the New World, under the equatorial zone, fewer Cyperaceæ and Rubiaceæ, and more Compositæ; under the temperate zone, fewer Labiatæ and Cruciferæ, and more Compositæ, Ericæ, and Amentaceæ, than in the corresponding zones of the Old World. The families which increase from the equator toward the pole (according to the *fractional method*), are the Glumaceæ, the Ericeæ, and the Amentaceæ. The families which decrease from the pole toward the equator are the Leguminosæ, the Rubiaceæ, the Euphorbiaceæ, and the Malvaceæ. The families which appear to attain the *maximum* under the temperate zone, are the Compositæ, the Labiatæ, the Umbelliferæ, and the Cruciferæ.

I have thrown together the principal results of this work in one table, but I enjoin naturalists to have recourse to illustrations of the several families, whenever any of the numbers seem doubtful. The quotients of the tropics are modified in such a manner that they are proportioned to regions whose mean temperature is from 28° to 20°, (from the level of the sea to 750 toises of height). The quotients of the temperate zone are adapted to the central part of that zone, between 13° and 10° of mean temperature. In the frigid zone, the mean temperature is from 0° to 1°. To this table of quotients or fractions, which indicate the proportions of each family to the total mass of phænogamous plants, might be added another, in which the absolute number of species might be compared. We here present a fragment which comprehends only the temperate and frigid zones.

	France.	North America.	Lapland
GLUMACEÆ, - -	460	365	124
COMPOSITÆ, - -	490	454	38
LEGUMINOSÆ, - -	230	148	14
CRUCIFERÆ, - -	190	46	22
UMBELLIFERÆ, -	170	50	9
CARYOPHYLLEÆ, -	165	40	29
LABIATÆ, - -	149	78	7
RHINANTHEÆ, - -	147	79	17
AMENTACEÆ, - -	69	113	23

These absolute numbers are taken from the works of Messrs Decandolle, Pursh, and Wahlenberg. The mass of plants described in France is to that of North America in the proportion of $1\frac{1}{2}:1$; to that of Lapland in the proportion of $7:1$ *.

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* A series of additional observations on this subject, so highly interesting to the philosophical botanist and the geologist, also by Baron Humboldt, will appear in our next Number.

GROUPS, founded on the Analogy of Forms.	Proportions to the whole mass of Phænogamous Plants.			SIGNS indicating the direction of Increase.
	EQUATORIAL ZONE, Lat. 0°—10°.	TEMPERATE ZONE, Lat. 45°—52°.	FRIGID ZONE, Lat. 67°—70°.	
AGAMOUS PLANTS, { Ferns, Lichens, Mosses, Fungi,	Plains, - - - $\frac{1}{15}$ Mountains, - - - $\frac{1}{5}$	$\frac{1}{2}$	$\frac{1}{1}$	↑
FERNS alone.	Country slightly Mountainous, $\frac{1}{20}$ Country very Mountainous, $\frac{1}{8}$—$\frac{1}{6}$	$\frac{1}{70}$	$\frac{1}{25}$	←→
MONOCOTYLEDONOUS PLANTS.	Old Continent, - - $\frac{1}{5}$ New Continent, - - $\frac{1}{6}$	$\frac{1}{4}$	$\frac{1}{3}$	↑
GLUMACEÆ, { Junceæ, Cyperaceæ, Gramineæ,	$\frac{1}{11}$	$\frac{1}{8}$	$\frac{1}{4}$	↑
JUNCEÆ alone.	$\frac{1}{400}$	$\frac{1}{90}$	$\frac{1}{25}$	↑
CYPERACEÆ alone.	Old Continent, - - $\frac{1}{22}$ New Continent, - - $\frac{1}{50}$	$\frac{1}{20}$	$\frac{1}{9}$	↑
GRAMINEÆ alone.	$\frac{1}{14}$	$\frac{1}{12}$	$\frac{1}{10}$	↑
COMPOSITÆ.	Old Continent, - - $\frac{1}{18}$ New Continent, - - $\frac{1}{12}$	Old Continent, - $\frac{1}{8}$ New Continent, - $\frac{1}{5}$	$\frac{1}{13}$	→←

LEGUMINOSÆ.	$\frac{1}{10}$	$\frac{1}{18}$	$\frac{1}{35}$	↓
RUBIACEÆ.	Old Continent, - - $\frac{1}{14}$ New Continent, - - 1	$\frac{1}{60}$	$\frac{1}{80}$	↓
EUPHORBIACEÆ.	$\frac{1}{32}$	$\frac{1}{60}$	$\frac{1}{500}$	↓
LABIATÆ.	$\frac{1}{40}$	America, - - $\frac{1}{40}$ Europe, - - $\frac{1}{25}$	$\frac{1}{70}$	→←
MALVACEÆ.	$\frac{1}{35}$	$\frac{1}{200}$	0	↓
ERICEÆ and RHODODENDRA.	$\frac{1}{130}$	Europe, - - $\frac{1}{10}$ America, - - $\frac{1}{36}$	$\frac{1}{25}$	↓
AMENTACEÆ.	$\frac{1}{800}$	Europe, - - $\frac{1}{45}$ America, - - $\frac{1}{25}$	$\frac{1}{20}$	↓
UMBELLIFERÆ.	$\frac{1}{500}$	$\frac{1}{40}$	$\frac{1}{60}$	→←
CRUCIFERÆ.	$\frac{1}{800}$	Europe, - - $\frac{1}{18}$ America, - - $\frac{1}{60}$	$\frac{1}{24}$	→←

EXPLANATION OF THE SIGNS: ↑ The denominator of the fraction diminished from the Equator toward the North Pole: ↓ The denominator diminished toward the Equator: ←→ The denominator diminished toward the Equator and toward the North Pole: →← The denominator diminished from the North Pole, and from the Equator toward the Temperate Zone.

ART. XII.—*History of Mechanical Inventions and Processes in the Arts.*

AS we are desirous of making this article as full and useful as possible, we have resolved in future to insert short notices of new and interesting patents, provided these notices are communicated to us by the patentees soon after the sealing of their patents.

1. *Account of Factitious Gilding for Chain-Bridges, and other Works in Iron.* Communicated by JOHN ROBISON, Esq. F. R. S. E.

The Moochees and Nuqquashes of India, who are the makers and painters of a variety of objects whose purposes require ability to stand the effects of the weather, use an application in ornamenting their works, which, in appearance, nearly equals gilding, and costs little more than common paint. It appears to me that this application might be useful in some cases in this country, particularly in chain-bridges, and other works where iron of a smooth surface is exposed to the atmosphere. I therefore use the freedom of troubling you with what I recollect on the subject.

In preparing the factitious gilding in the small way, a quantity of pure tin is melted, and poured into a joint of bamboo, (perhaps a foot long, and two or three inches in diameter), close at both ends, except the perforation at which the tin is poured in, which is instantly plugged up. The bamboo is then violently shaken, which, if well managed, soon makes the metal assume the form of a *very fine* grey powder: this being sifted, to separate any coarse particles, is mixed up in thin melted glue, and, if I recollect right, is levigated on a stone with a muller. The result is poured into dishes (commonly cocoa nut-shells) to settle, and the superfluous moisture poured off.

When to be applied, it should be of the consistence of thin cream, and is laid on with a soft brush, like ordinary paint. When dry, it appears like a coat of common grey water colour. This is gone over with an agate-burnisher, and then forms a bright uniform surface of polished tin;—a coating of white or coloured roghun (oil-varnish) is immediately laid over it, according as it may be intended to imitate silvering or gilding.

I have had tent-poles, travelling trunks, baskets covered with painted leather, and other articles, in constant tear and wear for years, in which, from its cheapness, this mode of ornamenting had been very liberally applied, and have often had occasion to remark the power which it appeared to have of resisting the effects of the weather.

On a first trial, some little difficulty of manipulation may be found, in bringing the tin to a sufficiently impalpable powder, and also in hitting the proper quantity of glue to be put in. If the size be too strong, the agate has no effect; and if too weak, the tin crumbles off under the burnisher. A very little practice will make the process exceedingly easy.

2. *Account of a New Copying-Press.* Communicated by the Inventor.

The following description of a very simple and ingenious new copying-press, has been transmitted to us by a correspondent, by whom it has been constructed and used.

In Plate X. Fig. 1. AB are the upper and under boards, of two inch hard wood, well seasoned. The axle CD is laid along the centre of the under side of the lower board, through the supports EF, and is seen separately at G. The one copied from is made of $\frac{3}{4}$th inch bar-iron, having notches HI at each end, filed down on one side only, and rounded to $\frac{2}{5}$ths of an inch in diameter. In these notches, the round heads of the bolts KL work; each of these being screwed, with a strong nut MN, for adjusting to different thicknesses of books. The upper board is raised, when the pressure is taken off, by the pieces of spiral spring-wire OP, each of which is sunk into a large bore, about half through the under board. The nuts MN press upon pieces of iron sunk into the upper board. The whole is supported on three feet, not represented, to avoid confusion. With a handle of nine inches, a pressure of from two to three tons can very easily be given. The application of this axle to the rollers of a lithographic-press, or even to the common printing-press, must be evident to any one, while it is capable of being constructed by the most common artificer.

3. *Description of a New Safety-Lamp for Mines.* By JOHN MURRAY, Esq. F. L. S. and Lecturer on Chemistry. Communicated by the Inventor.

My new safety-lamp, which is represented in Plate X. Fig. 2. consists of two concentric cylinders of thick glass, the space between being filled with water through a pipe at top, and represented in the figure, having an air-escape aperture on the opposite side. Over the flame of the wick is a bell or funnel, with a double recurved pipe issuing from its summit, and passing below the lamp, terminating immediately under a single central aperture.. Here, the products of combustion are discharged, (the excess is of course disengaged by the usual aperture at the top of the cylinder), and mingled with the explosive atmosphere rising from below, and passing to the flame of the lamp. This is again mixed more intimately at its immediate ingress, where it passes through the apertures represented on each side of the lamp. The rest may be inferred from a simple inspection of the figure, in which two of the ribs that fence in the outer cylinder (a guard from external injury) are supposed to be removed, in order to shew the internal arrangement to better advantage.

By a circular band of lead affixed to its base, the instrument will always fall vertically; and should it accidentally fall on its side, it will immediately recover its upright position.

The water will not spill in any condition of the instrument, for the resistance of the atmosphere will prevent this. It is shewn lower in the cylinders than it ought to be, in order to be clearly represented. Its expansion is compensated for. The water will preserve the inner cylinder of an equable temperature.

Hedged in by water, external injury may only affect the outer wall; but granting that the instrument is crushed to atoms in an explosive atmosphere, the worst that can happen is the extinction of the flame within by a flood of water.

I see no necessity for shielding the inner cylinder by metallic bars, because explosion cannot take place within.

The lamp is a self-regulator, and takes care of itself; for, as the quantity of azote, &c. will be in the ratio of the quantity of the disarmed explosive mixture, and consequent elongation of the spire of flame, so soon as it amounts to a *maximum* extinction takes place, and the comparative colour of the flame, with the varied phenomena of the exotic lambent flame, will afford an elegant measure of that explosive force which has been disarmed before its transmission from the portal below.

This lamp has been submitted to the ordeal of explosive atmospheres, with the most complete success. No explosion whatever occurs within the cylinder. When the explosive atmosphere, mixed with the product of combustion, passes towards the lamp, the colour of its flame is changed, and it shoots up into the bell or funnel, (which carries off these chemical products of flame, in order that they may be mixed with the explosive atmosphere, before it passes into the cylinder), and as the explosive mixture increases, a lambent attenuated flame plays silently round that of the lamp, which finally disappears; and when it has reached its *maximum*, it is tranquilly extinguished.

4. *Account of a New Patent Pocket Copying-Press, by* M. J. Brunelle.

This ingenious and useful invention is shewn in section in Plate X. Fig. 3., where *a* is the bottom of the press, made of the best gun-metal, and *bb* a pressing-board of wood, having above it a steel-plate spring *cc*, which rests upon ledges, and supports the pressing-board by the screw *d*. A strong steel-lever *e*, moving on the plane *f*, presses near its centre on the head of the screw *d*; and *g* is another lever, moving on the joint *h*, to which the power of the hand is applied. The damping apparatus contained in the box *i*, consists of a metallic cylinder, having several sheets of fine linen rolled round it, of the same size as the sheets of paper employed.

In using this press, the original letter is put into a transferring-book, and a blank-leaf of paper turned over upon it. A sheet of the damp linen is then laid upon the blank-leaf, and above that a leaf of oiled paper. The book being shut, and introduced between *aa* and *bb*, the hand is applied to the lever *g*, which presses down the lever *c* with great power, and communicates the pressure to the book by means of the knob *d* of the pressing-board *bb*. This patent was enrolled in June 1821.—See *London Journal of Arts*, vol. ii. p. 248.

5. *Mr* Brookedon's *Improvement on the Method of Drawing Cylindrical Wire.*

The improvement which we propose at present to notice, was made by Mr William Brookedon of Poland Street, and was secured by patent on the 20th September 1821. The usual method of making cylindrical wires, is to draw them through holes made in plates of steel, iron, or other metal. In this method, the holes were liable to be galled or enlarged by the wire in passing through them, so that the wires were less equal and cylindrical than might have been desired. The method which Mr Brookedon proposes to substitute in place of the old one, is founded on the ingenious idea of drawing the wire through cylindrical or conical holes drilled in " *Diamonds, Sapphires, Rubies, Chrysolites, or any other fit and proper hard gems or stones.*" Although the wire may be drawn through either end of the hole, yet the inventor prefers entering the wire at the smaller end, and drawing from the larger end of the holes.

It is very remarkable, that Mr Brookedon has not enumerated among his gems the *Garnet*, which we consider as better fitted for the purpose than any which he has mentioned. It is not only the *cheapest* and most easily obtained of them all, but has the property of giving less friction than almost any other substance. This interesting property of the garnet was established by the curious experiments of Coulomb on pivots *.

6 *Account of Mr* Witty's *Improvement on Pumps.*

The usual method of working pumps, either in distilleries, &c. or on board ships, is to force the water to the top of the barrel, and allow it to run off to a lower level.

It is quite clear, that if the water in this case descends from the top of the pump to a place of delivery much below the top of the pump-barrel, the fall of the water through this height is a mechanical force which is entirely wasted, and which may be actually employed in raising the water through a part of the pump-barrel. Mr Witty avails himself of this power in a very ingenious manner. "Instead of letting the water or liquid escape from a common pump at the usual place of delivery, I caused it to descend again in a syphon-pipe to the lowest level at which it can conveniently be delivered; and as this descent is considerable in ships, brew-houses, &c. a considerable saving of labour is effected in working pumps by a descending column of water or liquor, counter-balancing as much in length of the rising column in the pump, as the height which it descends in the syphon-pipe, to the place where it can be delivered." We have no doubt that this invention will be found to be of great practical value, as it relieves the men at the pump of a very great part of their labour. In cases of danger at sea, it may prove the means of saving both the ship and the crew.

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* See the new Edition of Ferguson's Lectures, Edin. 1822, vol. ii. p. 171, 172.

If we consider the water which in ordinary pumps falls from the top of the barrel to the place of its reception, as a mechanical force which is lost, we may avail ourselves of it, by various contrivances, for assisting in the work to be performed. In Mr Witty's contrivance, the men at the pump raise the water to the bottom of the short leg of the syphon, and it is then drawn through the syphon by the action of the longer branch. There are many cases, however, when we may allow the men to raise the water to the top of the barrel, and employ the direct force of the descending fluid to work another pump, or perform any other piece of work that may be required.

7. *Account of Mr* GLADSTONE'S *New Method of Propelling Steam-Boats.*

Several years ago, Mr Gladstone, an ingenious mill-wright of Castle-Douglas, contrived a kind of bucket-wheel for giving motion to thrashing-mills, and other kinds of machinery *, without knowing that he had been anticipated long ago by Mr Costar. This contrivance he has since modified, so as to enable it to be applied to propel steam-boats, as shewn in Plate X. Fig. 4., where A is a shaft or axle of iron, passing in the usual manner through the sides of the vessel. On each end of this shaft, on the outside of the said vessel, are firmly fixed two wheels of cast-iron, provided with studs or teeth round the whole circumference of each wheel, as represented in the figure at A. The distance between the two wheels of each pair, must be in proportion to the intended length of the floats or paddles. The propelling power is to be communicated to the shafts by the usual means, and thus a rotatory motion is given to both pairs of wheels.

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* See the New Edition of Ferguson's Lectures, vol. ii. p. 57.

2d, Two cast-iron wheels, with their circumference smooth, are fixed on an axle on each side of the vessel at B; their axles are to be of sufficient length to allow the two wheels of each pair to be fixed at the proper distance for receiving the chains and paddles, which are to pass over.

3d, Two endless chains are applied to the wheel, as in the figure at DD, so that one passes round each of the stud-wheels, and its corresponding plain wheel. Across these chains the paddles or floats are fixed, and between each pair of paddles the two chains are connected by cross bars of wood or iron, which are parallel to the paddles, and are securely bolted to both chains, so as to keep them at a proper distance, to suit them to the wheels, and prevent them having any lateral motion from the action of the surge.

The chains have openings at such distances as to fall exactly on the studs of the wheels, in order that the chains may always take hold of the studs during their rotation, so as to prevent their slipping on the wheels, although so slack as to form a curve in the water. The paddles are to be fixed in such a manner, that they will be perpendicular to the surface of the water, during their course between the wheels A and B, even when the resistance to their motion is greatest.

4th, On the outer edges of each adjoining pair of wheels, there is a projecting edging or rim, so that the two connected chains, with their strikers and paddles, may easily fall between the rims, thus affording an additional security against the effect of the surge, in displacing the chains. The length and breadth of the paddles must always be in proportion to the dimensions of the vessel.

8. *Account of Mr* H*AGNER's Improvements in the Art of Making White Lead and Verdigris.*

Mr Hagner's method of manufacturing white lead, consists in pouring melted lead into a revolving cylinder, for the purpose of granulating it by the rotatory action of the machine. When the lead is thus granulated, it is converted into white lead by the ordinary processes.

In the manufacture of verdigris, he also employs a revolving vessel, or a fixed vessel, in which agitators may be placed, and into these he puts copper in a very minute state of division. Pyroligneous acid or acetic acid, is then poured on the copper, so as to cover it only partially, and the whole is put into a state of agitation, so as to rub off the oxidated parts of the metal, and present fresh surfaces of it to the action of the acid. When the vessel is closed, he introduces carbonic acid gas during the operation of the machine, and continues the process until the verdigris is formed.

9. *Account of Mr* Johnson's *Method of Consuming the Smoke of Steam-Engines.*

In the year 1813, the late Mr Sheffield took out a patent for air-conductors to his improved reverberatory furnaces, which, though it was not one of the objects of the inventor, had the effect of consuming the smoke, by converting it into flame. The air-conductors of Mr Sheffield were afterwards directly applied to the consumption of smoke by Mr Wakefield of Manchester; and more recently, Mr Johnson, brewer at Salford, has taken out a patent for a contrivance for the same purpose, which is the counterpart of Mr Sheffield's air-conductor. Mr Johnson's contrivance is represented in Plate X. Fig. 5., where *e* is the ash-hole and fire-place; *a* the tube or leading part of the air-conductor; *b* its aperture or mouth; *d* the flues leading to the chimney; *i* the register; *k* its handle; *gh* the bridge of the furnace; *m* the iron-door for cleaning the flues; *f* a stop-well; *n* the steam-engine boiler.—See the *Technical Repository*, vol. i. p. 42., and the *London Journal of Arts*, vol. ii. p. 440.

10. *Account of Mr* Saul's *Fruit-Gatherer.*

This useful apparatus is represented in Plate X. Fig. 6., where *a* and *b* are a pair of cutters fixed to a pole, which may be lengthened by screwed joints, or other obvious means. At the lower end of the pole is a lever *c*, which may be fixed by a screw and socket to any part of the pole. The lever *d*, of the moving blade *b*, has a spring under it, to keep it open, and from the end of *d*, a string passes over the pulley *e*, to the handle *c*. By means of the arch and joint at *f*, the cutters may be set at any required angle.

When the fruit-gatherer is raised, so that the stalks of the fruit are included between the cutters, the string *ce* is pulled; the stalks are cut, and the fruit drops into the basket *h*.

11. *Mr* Aikin's *Method of Protecting Steel Articles from Rust by a Coating of Caoutchouc.*

It occurred some time ago to Mr Arthur Aikin, the ingenious Secretary to the Society of Arts and Manufactures, that melted caoutchouc would be found to preserve the surface of iron goods from oxidation, by the action of the atmosphere, in consequence of its undergoing almost no chemical change when exposed to the air,—its treacly consistence under ordinary degrees of heat, —its powerful adhesion to iron or steel surfaces,—and the facility with which it can be removed by a soft rag and a piece of stale bread.

The truth of this conjecture was afterwards established by direct experiment. Plates of iron and steel that had one-half of their surfaces covered with caoutchouc, remained unoxidated, while the unprotected parts were almost wholly corroded by exposure for five or six weeks in a laboratory.

The caoutchouc must be melted in a close vessel, to prevent it from being charred, and from taking fire. It melts nearly at the temperature at which lead fuses; and, when in a fluid state, it must be stirred with a horizontal agitator, by means of a handle rising above the vessel, to prevent the caoutchouc from burning to the bottom.

Mr Aikin communicated this useful discovery to Mr Perkins, who employs it in preserving his engraved steel blocks, plates, rolls and dies. Mr Perkins improved the process, by incorporating the caoutchouc with oil of turpentine, which makes it more easily applied, and which dries into a firm varnish, inaccessible to moisture, and easily removed by a soft brush dipped in warm oil of turpentine.—See the *Technical Repository*, vol. i. p. 55.

12. *New Method of Illuminating Houses with Gas.*

The great improvements which have taken place, both in the manufacture of gas, and in the methods of applying it for the purposes of illumination, render it extremely probable that it will be much more extensively employed in lighting up private houses. Many persons have an objection, which we confess is not without some foundation, to introduce the gas directly into their apartments; and it has accordingly been proposed to bring the gas to the windows, to allow it to burn on the outside, and thus to illuminate the room, without any of the annoyances which arise, both from the smell of the gas, and from the heat generated during its combustion.

In order to do this to the greatest advantage, the gas-pipe should be brought to the sill of the window, and should then have a gas-tight joint, by means of which it can be placed either vertically, when it is to be used, or horizontally, when the apparatus is to be removed altogether, or put aside during the day in a press or recess made in the wall to receive it. The lamp which is to protect the gas from wind and rain, should have fronts of glass either hemispherical or semicylindrical, so that no opaque line or bar may interfere with or break the cone of rays which enters the window. The back part of the lamp must be a reflector, of such a surface that it shall throw into the apartment all the rays that would otherwise not enter. The direct and reflected light which thus enter the apartment, might be rendered uniform, by means of an ornamental blind of the finest muslin, (varnished or not as may be found most advantageous); and if the blind has a landscape upon it, the most luminous portion, or that nearest the gas flame, might be made to have the appearance of the sun in the heavens.

In newly built houses, recesses might be constructed, in such a way that the lamp and gas-tube might turn round a joint, and be entirely concealed from view in the day-time.

The advantages of such a method of illumination are great and obvious. Instead of being annoyed by the constant en trance of servants to trim the lamp;—instead of having the furniture destroyed by the spilling of oil, and by the carbonaceous matter necessarily produced by either oil or wax burning within an apartment;—instead of having the temperature of overheated rooms increased by the heat of the lights;—instead of having the eye injured by the irritation which arises from brilliant flame;—and instead of having the apartment illuminated by a light constantly varying in intensity, we shall avoid all these evils, and have our houses lighted in the very same manner as they are by the light of day.

The disadvantages which attend this method are very few. We are prevented from excluding the cold air of winter by shutters and curtains; but in many cases this is an advantage, and when it is not desirable, the heat on the outside of each window will diminish the currents of cold air which might otherwise be admitted. A greater quantity of light will no doubt be necessary to produce the same degree of illumination; but the cheapness of gas renders such an objection of no weight.

The gas-light might also be established in the *stone*-walls of apartments, by means of gas and air pipes laid in the walls themselves, so that the air in the room should be entirely unconnected with that which supports the flame of the gas.

13. *Account of a New Process for separating Iron from other Metals.* By J. F. W. Herschel, Esq. F. R. S. L. & E. *

The following process, discovered by Mr Herschel, is of great value in the arts, from its being mathematically rigorous,—of general application, and having the advantage of facility, celerity, and cheapness.

The solution containing iron is to be brought to the *maximum* of oxidation, which can be communicated to it, by boiling with nitric acid. It is then to be just neutralised, while *in a state of ebullition*, by carbonate of ammonia. The whole of the iron to the last atom is precipitated, and the whole of the other metals present (which I suppose to be manganese, urium, nickel and cobalt,) remain in solution.

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* From the *Phil. Trans.* 1821, p. 293.

The precautions necessary to insure success in this process, are few and simple. In the first place, the solution must contain no oxide of manganese or cerium above the first degree of oxidation, otherwise it will be separated with the iron. It is scarcely probable, in ordinary cases, that any such should be present, the protoxides only of these metals forming salts of any stability; but should they be suspected, a short ebullition with a little sugar will reduce them to the *minimum.* If nitric acid, &c. be now added, the iron alone is peroxidised, the other oxides remaining at the *minimum.* Moreover, in performing the precipitation, the metallic solution should not be too concentrated, and must be agitated the whole time, especially towards the end of the process; and when the acid re-action is so far diminished, that logwood paper is but feebly affected by it, the alkaline solution must be added cautiously, in small quantities at a time, and in a diluted state.

If too much alkali be added, a drop or two of any acid will set all right again; but it should be well observed, as upon this the whole vigour of the process depends, that no inconvenience can arise from slightly surpassing the point of precise neutralisation, *as the newly precipitated carbonates of the above concentrated metals are readily soluble to a certain extent in the solutions in which they are formed, (though perfectly neutral).* In the cases of cobalt and cerium, this re-dissolution of the recent precipitation formed by carbonate of ammonia, is very considerable, and a solution of either of these metals thus impregnated with the metallic carbonate, becomes a test of the presence of peroxide of iron, of a delicacy surpassing most of the re-agents used in chemistry, the minutest trace of it being instantly thrown down by them from a boiling solution, provided no marked excess of acid be present. To be certain, however, that we have not gone too far, it is advisable, after separating the ferruginous precipitate, to test the clear liquor, while hot, with a drop of the alkaline carbonate. If the cloud which this produces be clearly re-dissolved, on agitation, we may be sure that only iron has been separated. If otherwise, a little acid must be added, the liquor poured again through the filter, so as to wash the precipitate, and the neutralisation performed anew.—P. 295.

The separation of Iron from *Uranium* cannot be accomplished by this process, as this metal possesses a property analogous to that which forms the subject of the paper. It may be done, however, by inverting the process. A mixed solution of *iron* and *uranium* being deoxidised, by a current of sulphuretted hydrogen, and then treated with an earthy carbonate, the iron passes in solution, while the uranium separates.—P. 299.

14. *Account of Mr* PHILLIPS' *Method of Propelling Vessels.*

Mr Phillips is, we believe, the first person who has proposed to place the paddle-wheels of steam-boats in a *horizontal position.* The greater part of this horizontal wheel is inclosed between decks. Each horizontal wheel carries eight vertical paddles, and each paddle has a piece of machinery connected with it, by which it is lowered into the water when it emerges from between decks, and, after giving its stroke, it is again elevated. The succeeding paddle is lowered in a similar manner, performs its stroke, and ascends like the one which preceded it. Mr Phillips conceives that vessels may be propelled in this manner in high or rolling seas with greater effect, than by the ordinary contrivances.

The idea of using a horizontal wheel, is, so far as we know, new and ingenious; but though such a contrivance, with paddles capable of being lowered and elevated, might answer in very slow motions, we fear that it will be found in practice, when a very rapid revolution of the wheel is absolutely necessary, to be not only inexpedient, but to be extremely liable to go out of order. Mr Phillips has taken out a patent for the invention, which he declares to consist in placing the paddle-wheels horizontally.

15. *An account of Messrs* REEDHEAD *and* PARRY'S *Method of Propelling Vessels.*

The principal object of this invention is to convert the steam-boat into an ordinary vessel, to be driven by canvas in stormy weather. In order to effect this, two horizontal channels are made to extend through the whole length of the vessel, with entrance and exit apertures for the water, which reaches nearly to their top. Two or more pair of paddle-wheels are mounted, with their lower parts immersed about one foot under the water in the channel. In stormy weather, the apertures of the channels may be shut by sliding shutters; and, if necessary, the water may be pumped out of the channels, so that the wheels are entirely closed in. The patentees state, that it may be sometimes desirable to form trunks on the outside of the vessel, in place of the channels above described. This patent appears to rest on the use of channels closed up every where, except at the entrance and exit apertures, on the use of several pairs of paddle-wheels, and on the power of shutting up all the propelling apparatus by means of sliding shutters *.

16. *Account of Mr* Hill's *Improvement on the Manufacture of Starch.*

The object of the patentee is to deprive the starch of all its colouring matter, and render it perfectly white, by the action of the oxymuriatic acid. When the starch is ready for boxing, it is reduced with water to the consistence of cream. The oxymuriate of lime is then added to it, and the whole continually agitated. A large quantity of water is next added; the mixture is well stirred, and the starch allowed to subside. The water is then drawn off, and diluted sulphuric acid poured upon the starch, and the whole agitated for some time. The starch is finally washed with repeated quantities of clear water, till all smell is removed from it.

17. *Account of Mr* Ward's *Alternating Steam-Engine.*

In a preceding volume (Vol. I. p. 348.), we have described the steam-engine of Mr Morey, in which the cylinder revolves along with the axle of the paddle-wheels. Mr Ward, an American gentleman, seems to have improved this construction. This new engine, as applied to steam-boats, is represented in Plate X. Fig. 7., where the cylinders *b*, *b* are placed *within the water-wheel cc* which revolves round axes or centre-pieces at *e*, fixed to the boat *dd*, and join on each side of the recess for the wheel. These centre-pieces, after traversing the boxes, are turned at right angles, and extend within the wheel, and towards its circumference, a distance equal to half the sweep of the piston-rod *a*. At this distance from the centre of the water-wheel, boxes are inserted in the centre-pieces as at *f*, to receive the gudgeons *g*, of the cylinder, which revolves upon them round its centre of gravity. The steam is conducted to and from the cylinder by means of a double pipe, so that the centre-pieces at *f* answer the quadruple purpose of an induction tube and eduction tube, a bearing for the water-wheel, and a bearing for the cylinder. The steam is admitted alternately into each end of the cylinder, by a contrivance similar to that used by Hornblower. The outer end of the piston-rod *a*, is attached to a cross-piece *p*, which is supported by gudgeons *g*, moveable in boxes in the arms *r r* of the water-wheel. From the middle of R proceeds the two wings *s s*, from the ends of which two rods *t t* extend, playing through steps *u u* on the sides of the cylinder. These rods are considered necessary, in order alternately to overcome the *inertia*, and resist the *momentum* of the cylinder, encountered in consequence of the irregularity of its motion.

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* Fuller descriptions, with drawings of these two inventions, will be found in the *London Journal of Arts*, vol. ii. p. 401. and 405.

The following is the mode in which the engine operates. The steam being admitted into the cylinder, by means of the induction-tube, the beginning and end of which is shewn at *i* and *k*, elevates the piston, and consequently the piston-rod *a*, which presses the gudgeons *g*, as it were against the circumference of the wheel, and in the direction of a tangent of a circle passing through the point of re-action *g*, and having for its centre that of the water-wheel. The upward stroke of the piston being performed, the piston with its rod *a* descends, and the cross-piece *p* along with it, the gudgeons *g* of the latter sliding in the arms *r r*. During the descent of the piston, the revolution of the cylinder is obviously retarded, but it is again accelerated when the piston takes its upward stroke. From this regular alternate acceleration and retardation in the motion of the cylinder, Mr Ward has given his engine the name of the Alternating Steam-Engine. A full account of this machine will be found in the *American Journal of Science*, vol. iv. p. 90,—102.

18. *Account of Mr* STEIN'S *Improvements in Steam-Engines.*

This ingenious contrivance, of which we can only give a brief notice, is the invention of our countryman Mr Robert Stein, formerly of Edinburgh. A general view of it is given in Plate IX. Fig. 8., and the object of the invention may be stated to be for raising steam by means of heated air, and afterwards employing the steam so raised, and the heated air combined with a portion of steam to elevate the piston of a double steam-cylinder. By the hopper *a*, the fuel is introduced at suitable periods by the revolution of the fluted roller *b*, which is fitted so closely as to prevent the admission of air, and the escape of the heated air within. The cinders and dust are discharged below through a similar air-tight apparatus. When the fire is lighted, a strong blast of air is thrown into the furnace through the pipe *c*, and this air, when heated and expanded, is conveyed along the pipe *d* to the high pressure cylinder *e*, where it works the piston, and escapes by the eduction-pipe *j*. The expansive force of this rarified air is increased by a jet of water occasionally admitted among the coals in the hopper *a*, which, descending into the fire, is converted into steam. The heated air, in passing along the pipe *d*, and through the boiler *f*, converts the water into steam, which, ascending through the pipe *g*, works the piston in the low-pressure cylinder *h*, and escapes by the condensation-pipe *i*. The temperature of the furnace, and the quantity of elastic vapour generated, are regulated by means of a stop-cock *k*, in the blast-pipe *c*, which has two passages, one going above, and the other below the fire. If the expansive force of the air in *d* is too great, it will raise up the loaded piston *m*, and by means of the chain passing over the pulleys *l l*, the handle of the stop-cock *k* will be elevated, and thus partly close the passage of the lower branch of the blast-pipe, which goes below the fire. When the heated air in *d* has too little elasticity, the piston *m* sinks by its own weight, lifts the lever of the cock *k*, opens the lower branch of the blast-pipe, and closes the upper one. A fuller account of this invention, and of some of the other ingenious contrivances which belong to it, will be found in the *London Journal of Arts*, vol. ii. p. 411.

Art. XIII.—*Account of the Hot-Springs of Furnas, in the Island of St Michael.* By J. W. Webster, M. D. Cor. Sec. L. S. N. E., M. W. S., &c.*.

The Hot-springs of the Valle das Furnas †, render this the most interesting spot in St Michael. The valley is nearly twelve miles in circumference, and is bounded on every side by mountains of various height. Its form, like that of the other inclosed valleys, which have already been described, is nearly circular, but its surface has considerable irregularity, rising here and there into small hills. A part of it is under tolerable cultivation, and it is inhabited by a few peasants. It is watered by many streams that wind through the plantations, till they unite to form a small river, called Ribeira Quente, or Warm River. After a circuitous course, the Ribeira Quente flows through a deep ravine, and empties itself into the sea on the southern side of the island at the base of Pico da Vigia.

The mountains surrounding this valley are composed chiefly of pumice; but compact lava and rocks of the trachyte family are seen on the face of many of the precipices. The columnar structure and vertical arrangement of these rocks are quite distinct in some places; in others, beds of the porphyry and pumice appear to alternate. They are sometimes separated by layers of fine sand or ashes. A few pieces of slaggy lava and scoriæ, are occasionally found at the foot of the mountains, but there are no large collections or beds of them.

At the bottom of one of the precipices, I found a number of pieces of a rock analogous to amygdaloid, and at the same time porphyritic. Each piece is composed of angular portions, apparently fragments, which are united by a yellowish-white siliceous substance, approaching in some respects to calcedony. It is hard and opaque, and has somewhat of a waxy lustre. The cavities on which the amygdaloidal character of this rock depends, contain a small quantity of mealy and radiated zeolite.

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* This description of the Springs of Furnas, is extracted from an interesting account of the Island of St Michael's, one of the Azores, published in America, by our former pupil Dr Webster.—R. J.

† The Portuguese word "*Furnas*," means caverns.

The hot-springs are situate towards one extremity of the valley, beyond a few cottages composing the village of Furnas. They are not seen at any distance, being surrounded by small hills, some of which there is great reason to believe, owe their origin in part, if not altogether, to the springs themselves. They are generally covered with short shrubs, but some of them are wholly devoid of any traces of vegetation. They are composed of clay of different degrees of compactness, which is variously, and often beautifully coloured by iron, under different degrees of oxidation. The clay is intermixed with fine pumice and masses of siliceous sinter. As we pass along the narrow road from the village to this spot, the gradual change from a fertile to a barren soil is observed, and within a few yards of the hot-springs, nearly all traces of vegetation are lost. At the extremity of the road the ground is almost snow-white, and then acquires a reddish tinge; this increases in intensity and brightness, and finally passes through an infinite variety of shades to a deep brown. Here and there, patches and veins of a bright yellow and purple colour, add to the singular aspect of this remarkable spot. The clay is in some places so much indurated as to retain an imperfect slaty character, but most of it is soft, and has an earthy aspect. It does not feel perfectly smooth when rubbed, but is full of hard grains, which are exceedingly minute; and when a mass of it is diffused in water, a quantity of fine siliceous particles is separated. It has many of the characters of tripoli. It is used by the peasants as an external application for cutaneous diseases, and is undoubtedly beneficial in some particular cases, from the quantity of sulphur it contains. Large pieces of siliceous sinter, of a grey colour, are imbedded in it, and it is covered in some parts by the same substance, which has accumulated upon it in layers, from an eighth of an inch to an inch in thickness. Near the extremity of the road, the beds of clay have been cut through to the depth of six or eight feet, and their structure is well displayed.

The vicinity of the springs is indicated by the increased temperature of the earth, a sulphureous odour, and the escape of vapour or steam from every crack and fissure in the ground. The temperature of the clay continues to increase as we advance, and a greater quantity of vapour is at last seen slowly ascending from the springs themselves.

The volumes of smoke and steam rolling upwards from the surface to a great height, till they are gradually diffused through the atmosphere, or mingle with the heavier clouds that crown the summit of the mountains, produce a striking effect. The confused rumbling and hissing noise that is heard for some time before we arrive in sight of the springs, increases at last to an incessant and terrific roar, and seems to issue from the very spot on which we stand. The earth returns a hollow sound, and great caution is required to avoid stepping into the pools and streams of boiling-water, with which its surface is covered.

The quantities of hot-water discharged through the innumerable orifices in the ground, is prodigiously great, and the different streams unite, forming a small river, that, still hot, joins the Ribeira Quente. The largest springs are termed Caldeiras, or boilers, and a shallow basin of earthy matter has been formed round each of them, by depositations from the water. Much of the water is constantly retained within these reservoirs, and its surface is more or less agitated by the escape of sulphuretted hydrogen gas, and the ejection of the water from below. The temperature of some of these springs on the 2d day of December, between three and four o'clock P. M., the thermometer standing at 63° Fahrenheit, the barometer at 29.4, was as follows:

207°	200°	96°	137°	203°
190	134	170	73	114
184	94	122	171	147.*

The basin of the largest spring, particularly designated as "The Caldeira," is circular, and between twenty and thirty feet in diameter. The water in this boils with much greater violence than in any other caldeira, and distinct loud explosions occur at short intervals, which are succeeded by a very perceptible elevation of the centre of the body of water within the basin. This is attended with a loud hissing noise, and the escape of great quantities of sulphuretted hydrogen gas, steam, and sulphurous acid vapour. On account of the high temperature and vast quantities of steam, it is dangerous to approach near the spring, except on the windward side. The cattle, however, are often seen standing on the opposite side, to free themselves, as it is supposed, from vermin. The peasants are in the habit of placing baskets filled with lupines, beans, and other vegetables, on the edge of the basin, where they are speedily cooked.

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* The above are put down in the order in which they were examined.

From the Great Caldeira, the water is conveyed to two or three small buildings, which are used as bathing-houses. The temperature of the water being so high, reservoirs have been sunk, by removing the earth to the depth of a foot or two, into which the hot-water is conducted, and allowed to cool; it is then received into bathing-houses, and its temperature raised at pleasure by the admission of more water immediately from the caldeira. The water is turbid, from the presence of a large quantity of aluminous earth, but which gives to it a peculiarly soft feel.

A few yards from the principal caldeira, is an elevation about fifty feet in height, and probably as many in extent, composed of alternate layers, of a coarser variety of sinter, and clay, including grass, ferns, and reeds, in different states of petrifaction. Not many years since, the side of this hill fell in, and discovered a deep and frightful cavern; smoke and steam at present issue from it in vast quantity, accompanied by a tremendous noise. The hill, indeed, appears to be a dome, covering an extensive abyss, from which, by another outlet nearer the summit, hot mud and stones have been occasionally ejected. Looking down through the opening, a body of water is seen boiling with great violence. An appalling roar is incessantly reverberated from side to side within the dome, and is increased, at short intervals, by sudden and violent explosions. The surface of this hill, the sides of the cavern, and the innumerable crevices in the ground, are coated with sulphur; in obtaining specimens of which, I found the heat and acid fumes almost suffocating. Every stone has been more or less changed, while not a shrub or plant flourishes for many yards around. The thermometer introduced into the fissures immediately rose to 120°, and in some places to 128° Fahrenheit.

Sulphur is so abundant and pure, that it might be collected in quantities sufficient to export; wherever a loose stone lies over one of the fissures, or where many stones are loosely heaped together, their under surfaces are soon covered with it; and by placing tiles, as is done at Solfatra, on which the sulphur could collect, an abundant supply of it would be obtained.

Wherever the water has flowed, depositations of siliceous sinter have accumulated, and circular basins, composed entirely of this substance, have been here and there formed round a spring. The siliceous matter rises, in many places, eight or ten inches above the level of the water, and is often exceedingly beautiful. Grass, leaves, and similar substances which have been exposed to the influence of the water, are more or less incrusted with silex, and exhibit all the progressive steps of petrifaction; some being soft, and differing but little from their natural state; while others are partly converted into stone, or are entirely consolidated. In many instances, alumina is the mineralizing material, which is likewise deposited from the hot-waters. I found branches of the ferns which now flourish on the island, completely petrified, preserving the same appearance as when vegetating, excepting the colour, which is now ash-grey. Fragments of wood occur, more or less changed, and one entire bed, from three to five feet in depth, is composed of the reeds so common on the island, completely mineralized, the centre of each joint being filled with delicate crystals of sulphur, in elongated, double four-sided pyramidical crystals, with a highly resinous lustre.

Round the springs, where the water has dashed irregularly over the edge of the basins, the depositations of siliceous matter are rough, and often present an appearance similar to those of Iceland, which have been so well compared, by Sir George Mackenzie, to the heads of cauliflowers [*]. The variety of siliceous sinter, which is most abundant in St Michael, is in layers from a quarter to a half inch in thickness, which are accumulated on each other, to the height often of a foot and upwards, constituting distinct and wide strata, many yards in extent. These strata are always parallel, and for the most part horizontal, but in some places they are slightly undulating. Between the layers of this substance is a loose white powder, which, on examination, is found to be nearly pure silex, with a small proportion of alumina. When moist, it is nearly gelatinous. The colour of the slaty variety is pearl-grey;* externally it is dull, but on the fresh fracture has a glistening lustre, and is translucent on the edges. The fracture is nearly smooth, inclining a little to conchoidal. It scratches glass with ease, and has a specific gravity of 2.107. It is infusible before the common blowpipe.

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[*] In the year 1817, I had an opportunity of examining the interesting suite of Icelandic specimens deposited by Sir George Mackenzie, in the apartments of

Another variety of sinter has a snow-white colour, and is externally wrinkled, abounding in slight depressions and protuberances, which are almost circular. This is found in delicate crusts, and often covers irregularly shaped masses of the other varieties. It has a very beautiful semi-opalescent lustre. The crusts are brittle, and seldom exceed the tenth of an inch in thickness. Their specific gravity is 1.886. Upon masses of a kind of conglomerate of altered lava and pumice, I noticed a very beautiful variety of Fiorite, in small circular cup-shaped portions, the edges of which are of a pure flesh-red, becoming gradually fainter, till the centres are perfectly snow-white.

Another variety has the following characters: its colour is snow-white, reddish and yellowish-white, passing, in some specimens, to yellowish-grey. It occurs in long, slender, capillary filaments, from one to four inches in length. The filaments cross each other in every direction. On the cross fracture, viewed with a microscope, a lustre between vitreous and pearly is observed. It is translucent, brittle, and light. When reduced to powder, and rubbed over the surface of a plate of glass, it scratches it. Its specific gravity is 1.866. It is insoluble in nitric, muriatic, or sulphuric acids, and is infusible before Brooke's blowpipe. A portion of this mineral was exa-

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the Royal Society of Edinburgh; but I recollect no specimens of siliceous sinter, which equal in beauty some of those from St Michael.

mined by my friend Dr Dana, who found it "fusible into a perfectly transparent glass, when mixed with an alkali, and that six grains of it, in fine powder intensely ignited in a platina crucible for fifteen minutes, lost 0.98125 grains, equal to 16.35 *per cent.*" It appears from Dr Dana's analysis, to consist of silex 83.65; water 16.35. It thus differs from the siliceous depositions of Iceland and Ischia, in the large proportion of water it contains, and in the absence of alumina and lime. It may be considered an hydrate of silex with more propriety than the hyalite of Frankfort, which M. Bucholz regards as such, and which contains but 6.33 of water *. It appears to be a new variety of siliceous sinter, and deserves to be designated by an appropriate name. From the island in which it occurs, I propose to call it Michaelite.

Wherever cavities exist in the large masses of sinter, and in the hills formed by that substance, and the fragments of lava and pumice, the silex has assumed a stalactitic form; and the stalactites are from one to two inches in length, and their surfaces are often covered with small brilliant crystals of quartz. It is impossible to convey any adequate idea of the beauty and variety of forms under which silex appears in St Michael, and mineralogists can here be supplied with specimens far surpassing those from any other localities as yet described.

Another variety of stalactite that occurs here is composed principally of alumina. These stalactites are rough and earthy, and their length is from one to six inches.

The more compact masses of sinter, broken down by the weather, and other causes, have been cemented together, with portions of obsidian, pumice, and scoriæ, into very beautiful breccia, which is in some places sufficiently hard to admit a good polish. The cement is siliceous sinter. The different substances of which this mass is composed, exhibit a great variety of colour, and the fractured surface is curiously mottled with green, red, grey, white, yellow, and black, in every variety of shade. Some of the portions have external characters analogous to those of wax-opal, and many are striped and spotted, while others are porphyritic. This breccia is evidently of recent formation, and appears indeed to be actually forming at this time in those parts of the beds where it is soft, and the cement gelatinous The alteration which the rock has undergone, in many places, where exposed to the steam and acid vapours, is remarkable. The different substances composing it have lost their colours, and have now a pretty uniform degree of whiteness, the brecciated structure remaining. The fragments are soft, and in many places have acquired a distinctly argillaceous character. Some of the elevations composed of this breccia are upwards of thirty feet in height. Wherever cavities occur in it they are lined with small stalactites, and botryoidal concretions of pearl-sinter (fiorite of Thomson) and alum appears under the form of a delicate efflorescence, or in minute crystals.

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* Klaproth analysed a quartzose concretion from the Isle of France, which contained 21 *per cent.* of water.

Besides the hot-springs already noticed, there are some others of less importance in different parts of the Valley of the Furnas, and bathing-houses have been erected in their vicinity. There are also many cold springs, the waters of which are abundant in carbonic acid and sulphuretted hydrogen gases. and they are strongly chalybeate. They occur in various parts of the plain, and some of them are so near the hot-springs, that the thumb may be placed in one of the former, the temperature of which is 70° or 80°, and the first finger of the same hand in one of the latter, at the temperature of 190° or 200°. The ground over which the water from the cold-spring passes, is covered with a thin coating of oxide of iron, and many of the loose stones have a beautiful metallic stain, which is sometimes iridescent.

ART. XIV.—*An Account of some Mistakes relating to Dr* BRADLEY'S *Astronomical Observations, and* HARRIOT'S *MSS.* By Dr ROBERTSON, F. R. S. Savilian Professor of Astronomy in the University of Oxford. In a Letter to Dr BREWSTER.

DEAR SIR,

THE following statement of facts will, I trust, do away mistakes into which many of your scientific readers may have been led by the passages herein quoted, relating to the publication of Bradley's astronomical observations, and also relating to certain manuscripts left by Harriot, the celebrated mathematician.

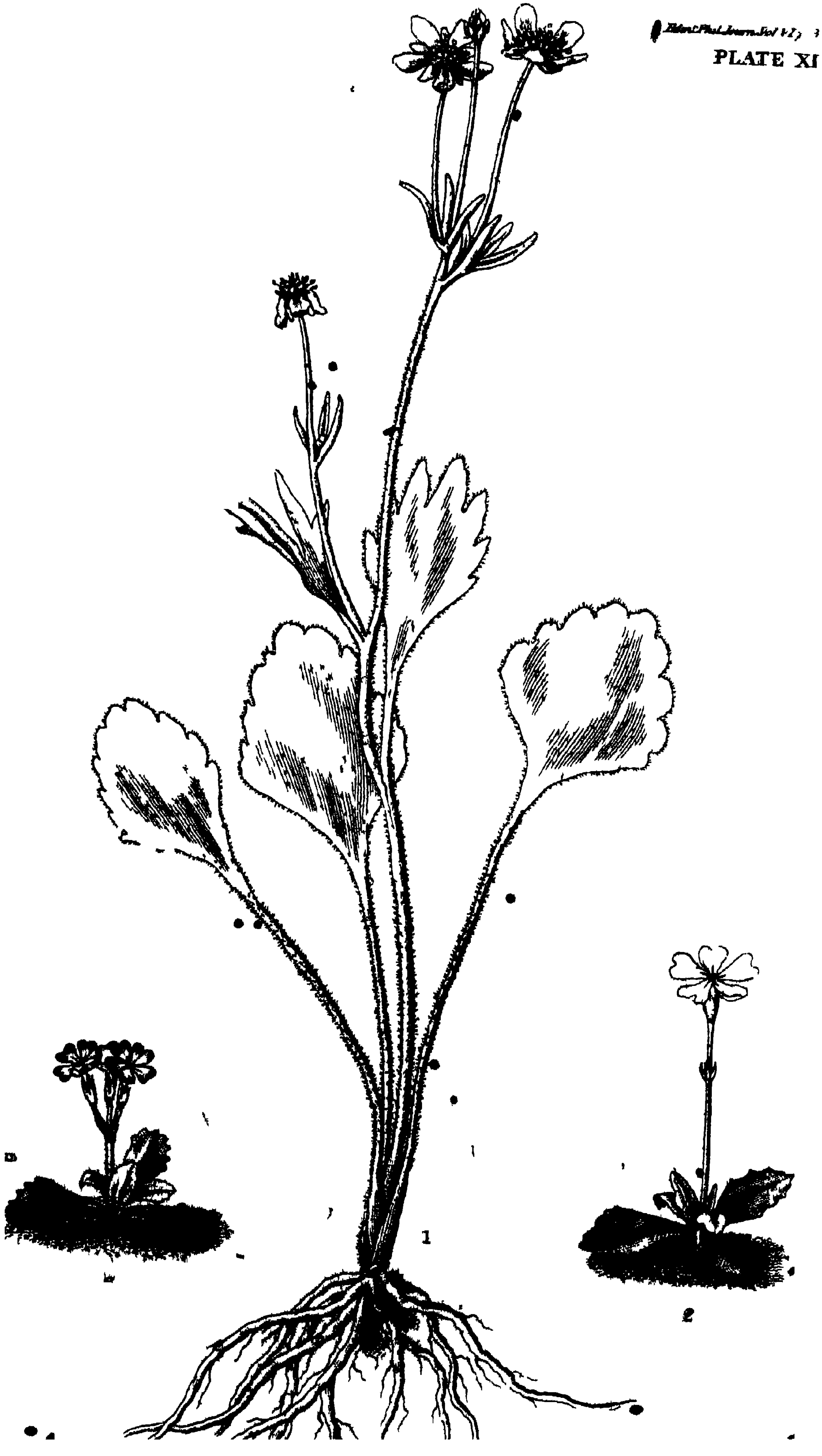
In the year 1812, Dr Thomson published his History of the Royal Society; and in pages 344–345. of the work, he concludes his account of Dr Bradley, with saying, " He left behind him an immense number of astronomical observations, in thirteen folio volumes, which were presented to the University of Oxford in 1776, on condition of their being printed and published,—a condition, however, not yet complied with."

Now, the truth is, that the first volume of Dr Bradley's observations, edited by the late Dr Hornsby, Savilian Professor of Astronomy, was published in 1798; and, in the preface, he gave an account of the causes which delayed its appearance. Being unable, on account of bad health, to extend his superintendence to what remained, the Delegates of the Clarendon Press requested me to undertake the task. To this I assented, and the second volume was published in 1805. In this volume, the Greenwich Observations are continued, from the date at which the first ends, not only to the time of Dr Bradley's death, but even to that of Mr Bliss, his immediate successor as Astronomer-Royal.

In No. LI. art. 2. of the *Edinburgh Review*, when speaking of Baron de Zach, it is said : " Several years ago he visited England, and resided there for a considerable time. He lived much in the family of Lord Egremont; and we owe to him the discovery of several unpublished MSS. of Harriot, one of the ablest and most inventive mathematicians of the age in which he lived. These the Baron found among the papers of the nobleman just named. They have since been consigned to the care of the University of Oxford; and are now, we have no doubt, in the progress toward publication."

The belief implied in the conclusion of what has been quoted, ought not to have been entertained; for the manuscripts in question had been examined at Oxford, had been declared to be unfit for publication, and had been returned to the nobleman to whom they belonged, more than sixteen years before the *Edinburgh Review* had arrived at No. LI

PLATE XI



The Delegates of the Clarendon Press, to whose care the MSS. had been consigned, were desirous that they should be published without delay; and, with this view, they earnestly requested me to examine the papers, and favour them with an account of their state and merit. Having intimated my compliance, the MSS. consisting of two bundles, were put into my hands, and the following are copies of the reports which I drew up upon them.

" The following are the titles of the papers contained in the bundle first examined.

1. Περι χωρίου ἀποτομῆς: seu De Spatii resectione. Propositio generalis: ex Lib. 7. Pappi.
2. De centro gravitatis pyramidis.
3. Ptolomaicum elementum de compositione rationum
4. Theoremata ad subtensas periferiarum.
5. Lemmata.
6. Problemata.
7. De Parabola.
8. De centro gravitatis trianguli.
9. De centro gravitatis parabolæ.
10. De Asymptotis.
11. De reflectione corporum rotundorum.

These papers, excepting the last, are in no point of view fit for publication. The greatest part of them consist of detached and unfinished explanations of the authors which he read; begun, according to all appearance, with the design of satisfying his own mind upon the subject before him, and dropped abruptly as soon as this satisfaction was obtained.

The 1st, 2d, 3d, 4th, 5th, and 6th, of the above mentioned articles, are of this kind. The 7th, 8th, 9th, and 10th articles, seem to have been entered upon with an intention of treating the subjects in a more perspicuous way than any which had been pursued before his time; and had he written the 7th and 10th with a view to publication, there is every reason to suppose that in these two he would have succeeded in his design. In point of matter, as far as they extend, they are ingenious improvements upon Apollonius; but the same improvements, fully and elegantly demonstrated, are to be found in Mydorgius's Conic Sections, published in 1631. I should suppose that Ha[illegible] had not read Archimedes when he wrote the 8th and 9th articles, as they are so very much inferior to what we have by that celebrated mathematician on the subject.

To these remarks upon the substance of the first ten articles, it may be proper to add, that they are destitute of the principal particulars requisite in regular mathematical composition. No first principles are laid down; due arrangement is overlooked; and the demonstrations, often defective, are expressed in a kind of algebraical short-hand. In saying this, I by no means intend to insinuate any thing disrespectful to the memory of Harriot. I offer these observations as reasons for my firm persuasion that he never intended the papers for publication; and that it would be injurious to his reputation to print them.

The paper *De reflectione corporum rotundorum*, when compared with those already mentioned, may be considered as highly finished, but to its publication some strong objections may be made. Harriot himself states its imperfections, in his letter which accompanies this *; and to these imperfections it may be added, that every thing depending upon the composition and resolution of forces is so much better understood, and more clearly treated, since the great discoveries of Sir Isaac Newton, that it would suffer much upon a comparison with modern publications. The subject is more fully and elegantly handled in Keill's Introduction to Natural Philosophy.

Of the other bundle of papers.—To a great many of these papers there is no title, nor do they admit of any specific description. They appear to be rough calculations of some particulars which he wished to ascertain, without any allusion to the data with which he set out, or obvious tendency to the object in view. Others admit of classification, and afford abundant proof of Harriot's zeal in the cause of science, and of his unremitting attention to its improvement.

The first class of this description relates to the spots on the sun. From these papers it appears, that he first began to observe the spots on the 8th of December in 1610, and that he continued to observe them, at irregular intervals, to the 18th of January 1613. The observations recorded are 199 in number, and the accounts of them are accompanied with rough drawings, representing the number, position, and magnitude of the spots. From the manner, however, in which these observations appear to have been made, and also from that in which I find them recorded, I do not think that Harriot ever intended them for publication; nor do I think that the publication of them now would either satisfy rational curiosity, or contribute in the smallest degree to the advancement of astronomy. The circumstances under which the observations were made are very briefly and very vaguely recorded, and consequently no calculations can be founded upon them likely to lead to accurate conclusions. These deficiencies I am inclined to attribute, partly to his having had no intention to publish on the subject, and partly to the imperfection of astronomical and philosophical instruments in his time.

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* This was a copy of a letter to his patron the Earl of Northumberland, upon the nature of his paper, acknowledging its want of first principles, and its brevity, but intimating that he thought his Lordship would comprehend it, notwithstanding its defects.

From this class of papers of which I am now speaking, it plainly appears, that Harriot had no coloured glass to defend the eye, for the following expressions frequently occur: "A mist,"—"a notable mist,"—"misty and cloudy,"—"the sonne was somewhat to cleare. There being no cloudes but only thick ayer,"—"convenient thin cloudes," &c.

As there is no reason to doubt of his diligence, I think that such expressions as the following are to be attributed to the imperfections of his instruments, and not to his want of care: "The altitude of the sonne being 7 or 8 degrees,"—"the sonne being 3 or 4 degrees hy," &c.

The next class of papers (fixed together with a pin) which met my eye, is entitled, "Descriptio parabolæ per circularum motum." This I proceeded to examine, with sanguine hopes of finding a practical method of describing a parabola by an uninterrupted motion. My hopes, however, quickly vanished; for this class only contains diagrams so rough and confused, that it does not appear from them, upon what property of the circle he founded his attempt.

After this disappointment, I proceeded to examine a class of papers entitled "De Jovialibus Planetis." From two pages of these papers, it appears, that he first observed Jupiter's Satelites on the 17th of October 1610, for both of them have this date; and at the top of one of them, there is this expression, "My first observation of the new planets;" and at the top of the other, "My first observation and others following of the new found planets about Jupiter." At the top of another page, there is this expression, "The second yeares observations, being anno 1611, of the Joviall Planetts;" and in this same page, there are the following dates prefixed to his accounts of observations: "Syon. Octob. 1."—"Octob. 6."—"Dec. 11."—"Syon. $\frac{1611}{1612}$, January 12."—"January 13."—"January 26."—"February 15."—"February 17."—"Feby 26."

Rough drawings of the positions of the satellites, and rough calculations of their periodical revolutions, accompany the brief statements of the observations; but, in my opinion, astronomy could not be advanced by the publication of any part of them.

The other papers which admit of classification, may be entitled, Observations of the Moon,—Observations of the Comets of 1607 and 1618,—An Examination of Willebrord Snell's Observations for determining the length of a degree of a meridian,—"The Effect of the Decree of the Councell of Neace for the observation of Easter-day,"—"the Doctrine of Nautical Triangles,"—Remarks on Eratosthenes, Tycho, Kepler, Paul Hainzelus, and Vieta.

It is needless to enter into a minute description of these papers, as they are not drawn up with any degree of regularity and precision, and as it evidently appears that they never were intended for publication."

Upon the whole, it is my opinion that the publication of the papers mentioned in this report could only tend to prove that Harriot was very assiduous in his mathematical studies, and in his observations of the heavenly bodies; it could not contribute to the advancement of science. I am, Dear Sir,

Yours, &c. &c.

A. ROBERTSON.

OBSERVATORY, OXFORD,
Jan. 22. 1822.

ART. XV.—*Description of some new and rare Plants discovered in Canada, in the year* 1819. By JOHN GOLDIE. (Communicated by Dr HOOKER.)

THE collection of plants from which those in the following list are selected, was gathered under circumstances so untoward, and so unfavourable for botanical research, that I shall probably be pardoned for prefacing my account of them with a short notice of the journey, of which they were the produce, and the motives of it.

Having had for many years a great desire to visit North America, chiefly with a view to examine and collect some of its vegetable productions, I contrived, in 1817, to obtain as much money as would just pay my passage there, leaving, when this was done, but a very small surplus.

In the month of June I sailed from Leith, and landing at Halifax, remained for some days botanizing in the neighbourhood of that place, where I met with several plants which were interesting to me, especially a yellow flowered variety of *Sarracenia purpurea*, which I have never since seen elsewhere. From hence I went to Quebec, carrying with me all the roots and specimens that I had obtained, which, together with the produce of two weeks' researches in the neighbourhood of Quebec, I put on board a vessel which was bound for Greenock, but never heard of them afterwards. Hence I proceeded to Montreal, where, meeting with Mr Pursh, author of the North American Flora, he advised me to turn my course towards the north-west country in the following spring, and promised to procure me permission to accompany the traders leaving Montreal. I travelled on foot to Albany, and then proceeded by water to New York. I remained but a short time in this last place, for I explored the eastern part of New Jersey,—a country which, though barren and thinly inhabited, yet presents many rarities to the botanist, and gave me more gratification than any part of America that I have seen. At a place called Quaker's Bridge I gathered some most interesting plants, and having accumulated as large a load as my back would carry, I took my journey to Philadelphia, where I staid but a very short time; for knowing that a ship was about to sail from New York to Scotland, I hastened to return thither; and having again entrusted my treasures to the deep, I had again, as the first time, the disappointment of never obtaining any intelligence whatever of them.

My finances being now extremely low, and winter having commenced, I hardly knew what to do; but after some delay, went up to the Mohawk river, where I found employment during that season as a schoolmaster. I quitted this place in April 1818, and proceeded to Montreal, expecting to be ready to depart on my journey towards the north-west country. I was disappointed in finding that Mr Pursh had left Montreal for Quebec, and that even if present, his interest would scarce have been sufficiently strong to have obtained for me the assistance and protection which I desired. My only alternative was now the spade, at which I worked all summer, excepting only two days in each week, which I devoted to botanizing, and went also a little way up the Otowa or Grand River, the only excursion of any length which I accomplished. In the autumn I shipped my collection of plants, and in two months had the mortification to learn that the vessel was totally wrecked in the St Lawrence. Thus did I lose the fruit of two years' labour. During the next winter I did little, except employing myself, with such small skill as I was able, in designing some flower pieces, for which I got a trifle. Early in the following spring I commenced labour again, and by the beginning of June had amassed about 50 dollars, which, with as much more that I borrowed from a friend, formed my stock of money for the next summer's tour. I started in the beginning of June from Montreal, and passing through Kingston, went to New York, to which, after an excursion to Lake Simcoe, I returned; then visited the Falls of Niagara and Fort Erie, and crossed over to the United States. Keeping along the eastern side of Lake Erie for ninety miles, I afterwards took a direct course to Pittsburgh on the Ohio, which, owing to the advanced state of the season, was the most distant point to which I could attain. On my return I kept along the side of the Alleghany river to Point Ollean, in the State of New York, then visited the salt-works of Onondago and Sackett's Harbour on Lake Ontario, whence, proceeding to Kingston, I packed up my whole collection, with which I returned to Montreal, and, embarking in a vessel which was bound for Greenock, got safely home; the plants which I carried with myself being the whole that I saved out of the produce of nearly three years spent in botanical researches.

In spite of the ill fortune which has hitherto attended my endeavours, I have still so great a desire to bring American plants and seeds to this country, that I purpose, in the ensuing spring, if my pecuniary circumstances will permit me, to make another excursion to that country, for the purpose of exploring the forests which lie towards the west.

TETRANDRIA MONOGYNIA.

SWERTIA.

Corolla rotata. *Nectariferi pori* ad basin laciniarum corollæ. *Capsula* unilocularis, 2-valvis.

Swertia *deflexa*, corollis campanulatis quadrifidis corniculatis, cornubus deflexis, foliis ovato-lanceolatis.

S. *deflexa*, Smith in Rees' Cycl. v. 34.

S. *Michauxiana*, Schultes' Syst. Veget. v. vi. p. 131.

S. *corniculata*, Pursh Fl. Amer. Sept. v. i. p. 101. (Not Willd.)

Hab. Shores of the St Lawrence, near its mouth.

Although this species is described by Pursh under the name of S. *corniculata*, yet he, with great propriety, intimates, that the American plant is distinct from the original Siberian one of that name, principally on account of the deflexed horns of the corolla. The present individual is annual or biennial, smooth, 6–8 inches high, simple, somewhat four-angled. *Lower leaves* spathulate, the rest ovato-lanceolate, all opposite, three-nerved. *Flowers* axillary and terminal; the axillary ones upon bibracteated racemes, the terminal ones nearly umbellate, with four small leaves at the base resembling an involucre. *Calyx* deeply four-partite, the segments lanceolate, rising erect between the horns of the corolla. *Corolla* erect, almost campanulate, veined, greenish-yellow, purplish below, divided into four, ovate, acute segments, and at the base furnished with four deflexed horns, more than half as long as the corolla. *Stamens* four; inserted about the middle of the corolla, alternate with the segments, short. *Pistil* oblong, with two short styles. *Plant* turning almost black when dried.

PENTANDRIA MONOGYNIA.

LITHOSPERMUM.

Corolla infundibuliformis, fauce perforata, nuda. *Calyx* quinquepartitus. *Semina* ossea, nitida.

Lithospermum *linearifolium;* fruticosum, foliis linearibus appressis pubescentibus, floribus lateralibus terminalibusque, nucibus impresso-punctatis, caulibus erectis.

Hab.. Only on the sandy-beach at the head of Lake Ontario, in July, and without flowers.

The *L. angustifolium* of Michaux agrees in some points with this plant, especially in the pericarp; yet as he describes it as procumbent, and Pursh pronounces it annual, and adds, that woods are the places of its growth, so I should think there could be no doubt as to the specific difference of the two individuals.

PRIMULA.

Calyx quinquedentatus. *Corolla* hypocrateriformis, tubo cylindraceo, ore aperto. *Capsula* unilocularis, decemfidus

Primula *pusilla;* foliis obovato-spathulatis repando-dentatis, subtus scapoque farinosis, umbella pauciflora, corollæ tubo calyce vix longiore, laciniis obcordatis obtusis, Pl. XI. f. 2. 2.

Hab. Near Quebec.

This is a minute and delicate species; its whole height, including the scape, not exceeding two or three inches. *Flowers* very pale purple, almost white. From *P. mistassinica* it differs by its very much smaller dimensions, shorter capsules, and particularly its flowers, of which the calyx is oblong, and almost equal to the tube of the corolla in length. The divisions of the corolla are considerably broader and more obtuse, more resembling those of *P. farinosa*, or even of *P. scotica*, from which two species again, the form of its leaves keeps the *P. pusilla* distinct.

Of this species I have living plants at Ayr. Others I sent to Edinburgh; and from two which flowered last summer in the garden of P. Neill, Esq. Canonmills, the accompanying drawings (Plate XI. Fig. 2, 2.) were made, by R. K. Greville, Esq. In its wild state the flowers are from four to eight in number.

CAPRIFOLIUM.

Bacca trilocularis, polysperma, distincta. *Corolla* tubulosa, longa, quinquefida *Calyx* quinquedentatus.

Caprifolium *pubescens;* spicæ verticillis terminalibus approximatis subcapitatis, foliis late ovatis sessilibus breviterque petiolatis pubescentibus ciliatisque, subtus glaucis, summis connato-perfoliatis.

Hab. Uppe Canada, near Kingston, and near Lake Simcoe. *Fl. July.*

Evidently allied to *C. ciliosum* of Pursh. Besides the leaves being ciliated at their margins, which is the character of that plant, having them also decidedly pubescent, especially on the under side: the upper connate leaves alone being almost glabrous. The *flowers* are large, handsome, and of a golden yellow colour, slightly hairy, with a long slender tube, which is a little inflated at the base, the limb very unequally 2-lipped. The *stem* is climbing, 6–8 feet high, hairy. On the older stems and branches the leaves are petiolated, on the younger ones sessile.

XYLOSTEUM.

Baccæ duæ basi connatæ, biloculares, polyspermæ. *Corolla* infundibuliformis, subæqualis. *Calyx* quinquedentatus.

Xylosteum *oblongifolium;* baccis coadunatis, foliis oblongis lanceolatisque obtusis junioribus præcipue corollisque pubescentibus.

Hab. In one spot only in a swamp on the Island of Montreal. *Fl. July.*

A *shrub* of about four feet in height, much branched, with pale glabrous bark. *Leaves* lanceolate, and very pubescent on both sides in the younger branches, oblong, obtuse, and only slightly pubescent beneath in the older ones, veiny. *Peduncles* about an inch long. *Germens* coadunate, producing two yellowish pubescent flowers. *Bracteas* two, excessively minute, broadly ovate, appressed, and, as well as the scarcely lobed calyx, glabrous *Berries* red.

Pursh has no species of this genus with united berries like the present plant, nor do I find it to agree with any described species of other authors. I possess living plants of it at Ayr.

VIOLA.

Calyx pentaphyllus. *Corolla* pentapetala, irregularis, postice cornuta, (aut ecalcarata). *Antheræ* apice membranula cohærentes, aut distinctæ. *Capsula* supera, trivalvis, unilocularis.

Viola *Selkirkii*; acaulis, foliis cordatis crenato-serratis pilosiusculis, petalis imberbibus, calcare subæquilongo crasso obtusissimo.

V. Selkirkii, *Pursh* MSS.

Hab. Mountains about Montreal, nowhere else. *Fl. July.*

Root perennial, somewhat creeping. *Leaves*, several from the same root, about ¾ths of an inch long, broadly heart-shaped, the notch at the base deep, so as to form two distinct lobes; the margin crenato-serrate, the upper surface having a few scattered hairs, the under side quite destitute of them, and of a paler colour. *Petioles* slender, glabrous. *Flower-stalks* scarcely longer than the leaves, with two lanceolate bracteas above the middle. *Calyx* with broadly ovate, acute, glabrous segments. *Petals* blue, obovate, beardless; *spur* nearly equal to the limb in length, very thick, and remarkably obtuse. The general aspect of this plant is very similar to that of *V. blanda*. but the leaves are more acute, and far more serrated, and the spur is very different from that of *V. blanda*, as from all the others which belong to the same division of the genus, thus forming one of the most striking peculiarities of the species.

I showed this plant to Mr Pursh at Montreal, and he informed me that it was what he called *V. Selkirkii*; and hence I have thought it right to adopt his name.

PENTANDRIA TETRAGYNIA.

PARNASSIA.

Calyx quinquepartitus. *Petala* quinque. *Nectaria* quinque, cordata, ciliata, apicibus globosis. *Capsula* quadrivalvis, bilocularis. *Receptacula* parietalia. *Semina* membranaceo-marginata.

Parnassia *caroliniana*; foliis radicalibus suborbiculatis, nectariis trisetis.

P. *caroliniana*, Pursh Fl. Amer. Sept. v. i. p. 208.

Hab. Island of Anticosti, Gulph of St Lawrence, *Mr Pursh.* I merely mention this for the sake of the habitat.

PENTANDRIA HEXAGYNIA.

DROSERA.

Calyx quinquefidus. *Petala* quinque. *Capsula* unilocularis: apice tri-quinquevalvis. *Semina* plurima. (Styli etiam sex. Folia pilis glandulosis obsita).

Drosera *linearis*; scapis radicatis, simplicibus, foliis linearibus obtusis, petiolis longissimis nudis.

Hab. Lake Simcoe, Upper Canada. *Fl. June.*

This species, at first sight, appears just to hold an intermediate place between *D. anglica* and *D. filiformis*, and is yet sufficiently distinct from both. The outer, or primordial *leaves*, are, as Pursh describes those of *D. filiformis* to be, destitute of glands, as also are the long petioles of the upper leaves. All the leaves are decidedly linear and obtuse, by no means spathulate or lanceolate. *Flowers* few. *Calyces* glabrous.

OCTANDRIA MONOGYNIA.

ŒNOTHERA.

Calyx tubulosus, quadrifidus, laciniis deflexis deciduis. *Petala* quatuor, calyce inserta. *Stigma* quadrifidum. *Capsula* quadrilocularis, quadrivalvis, infera. *Semina* nuda, receptaculo centrali tetragono affixa.

Œnothera *Canadensis*; caule glabriusculo, foliis anguste lanceolatis sessilibus, repando-dentatis margine obscure ciliatis, capsulis oblongo-clavatis acutangulis sessilibus.

Hab. Island of Montreal.

This plant, which I took at first sight to be the *O. pumila*, I find, upon examination, has the flowers thrice as long as that plant; their diameter is an inch and a half, and the leaves are decidedly repando-dentate. The *tube* of the flowers, which is long and very slender, and the germen, as well as the back of the segments of the corolla are furnished with scattered hairs. The *stamens* are half as long as the segments of the corolla.

DECANDRIA MONOGYNIA.

PYROLA.

Calyx quinquepartitus. *Petala* quinque. *Capsula* quinquelocularis, angulis dehiscens.

Pyrola *rotundifolia*, *Var.*; floribus flavo-virescentibus.

Hab. Not uncommon in woods.

This may be the *P. chlorantha* of Swartz., found on the Continent of Europe, but I can see no character sufficient to distinguish it from *P. rotundifolia*.

Pyrola *asarifolia?*; pistillo declinato, foliis orbiculato-reniformibus reticulatis, scapo squamis sparsis (bracteisque) convolutis vaginantibus.

P. *asarifolia*, Mich. Fl. Amer. Bor. v. i. p. 251. Pursh Fl. Amer. Sept. v. i. p. 299. ?

Hab. Swamps, Canada; rare.

I cannot help feeling considerable doubt as to this plant being actually the same with that of Michaux and Pursh. It is singular that neither of these authors should have noticed the strongly reticulated appearance of the leaves, which, by the tightness of the veins, become wrinkled or even bullate. The scales are indeed a striking character both of Michaux's plant and mine. The latter writer does not notice the colour of the flowers, but Pursh says that they are yellowish-green, and in our plant they are decidedly reddish-purple. Their general structure is very similar to those of *P. rotundifolia*; the stigma has five erect points.

May not the *P. asarifolia* of Pursh, which was found in *Beech woods*, in the *mountains* of *Pennsylvania*, be different from that of Michaux, and from the present individual, of which the habitat is *swamps* in *Canada?*

DECANDRIA TRIGYNIA.

STELLARIA.

Calyx pentaphyllus, patens. *Petala* quinque, bipartita. *Capsula* ovata, unilocularis, polysperma, apice sexdentata.

Stellaria *longipes*; glaberrima, foliis lineari-lanceolatis, pedunculis terminalibus dichotome ramosis bracteatis, pedicellis longis, petalis late obovatis bipartitis calyce obtuso trinervi vix longioribus.

Hab. Woods near Lake Ontario. *Fl. June.*

Stem long, filiform, square, and, as well as the whole plant, quite glabrous. *Leaves* narrow, linear-lanceolate, patent. *Peduncles* branched in a dichotomous manner; *pedicels* very long and slender, with two ovate acute green bracteas, scariose at the margins. *Flowers* drooping before expansion. *Calyx-leaves* ovate, very obtuse, 3-nerved, margins scariose, scarcely shorter than the broad bipartite petals.

This has quite the habit of a *Micropetalum*, and especially of *M. lanceolatum*, but the calyx is remarkably obtuse, the styles are only three in number, and the petals are very broad and decidedly bipartite.

ARENARIA.

Calyx pentaphyllus, patens. *Petala* quinque, integra *Capsula* unilocularis, polysperma.

Arenaria *lateriflora*; foliis ovatis obtusis, pedunculo laterali biflora.

A. lateriflora, Willd. Sp. Pl. v. ii. p. 718. Pursh, Fl. Amer. Sept. v. i. p. 317.

Hab. About Montreal.

The stamens of this species have (although unnoticed by any author) all their filaments hairy; five of them alternately shorter; the longer ones considerably thickened.

DECANDRIA PENTAGYNIA.

CERASTIUM.

Calyx pentaphyllus. *Petala* bifida, aut marginata, passim integra. *Capsula* unilocularis, apice dentatim dehiscens. (Stamina etiam 4–5.)

Cerastium *pubescens*; pubescenti-hirtum, caule deflexo-piloso, foliis lineari-lanceolatis intermediis longioribus, panicula terminali subquadriflora, petalis acute emarginatis, calyce duplo longioribus.

Hab. Stony beach near Kingston, Upper Canada. *Fl. June.*

Stems numerous, about six inches long, branching from below in a dichotomous manner, very hairy, hairs deflexed. *Leaves* an inch long, rigid, pubescent. *Calyx-leaves* ovato-lanceolate, hairy, with the hairs erect, the margins white and scariose.

In habit it comes nearer *C. arvense* than any species I am acquainted with. In some respects it accords with Pursh's *C. tenuifolium*, and it quite agrees with a plant in Dr Hooker's herbarium, found in 1816 by Francis Boott, Esq. on the hill behind Billows Falls, New Hampshire, who therefore has the credit of having first discovered this new species of Cerastium.

DODECANDRIA TRIGYNIA:

EUPHORBIA.

Calyx monophyllus, ventricosus. *Corolla* tetra- vel quinque petala calyce insidens. *Capsula* tricocca. (Plantæ lactescentes Stamina diverso tempore assurgentia.)

Euphorbia *pilosa*; umbella quinquefida, trifida, bifida, involucris ovatis, petalis integris, foliis lanceolatis subpilosis apice serrulatis.

E. *pilosa*, Pursh, Fl. Amer. Sept. v. ii. p. 607.

This, which Mr Pursh gives only as an inhabitant of Maryland and Virginia, I found in Canada about Montreal.

ICOSANDRIA POLYGYNIA.

DRYAS.

Calyx simplex, octofidus. *Petala* octo. *Semina* caudata, pilosa.

Dryas *integrifolia*; foliis integerrimis.

D. *integrifolia*, Fl. Dan. t. 1216.

D. *tenella*, Pursh, Fl. Amer. Sept. v. i. p. 350.

Hab. Anticosti, Pursh.

The individual now under consideration is unquestionably the *D. integrifolia* of the Flora Danica, which was first found in Greenland, and afterwards was only known to grow in one spot in America, viz. the White Hills in New Hampshire, until Mr Pursh observed it in the station above given.

POLYANDRIA POLYGYNIA.

RANUNCULUS.

Calyx pentaphyllus. *Petala* quinque, intra ungues poro mellifero. *Semina* nuda.

Ranunculus *rhomboideus*, foliis pubescentibus, radicalibus longe petiolatis rhomboideis integris serratis, caulinis palmatis, floribus profunde laciniatis, calyce patente piloso. Pl. XI. f. 1.

Hab. In dry sandy fields, near Lake Simcoe, Upper Canada. *Fl. July.*

Root fasciculato-fibrose. *Whole plant* rather thickly pubescent, almost woolly. *Stem* about 6–8 inches high, angled, bearing very few *leaves*; those springing from the root are almost exactly rhomboid, undivided, crenato-serrate in their upper half. About two of the *stem-leaves* are obovato-palmate, tapering down into a foot-stalk; the uppermost or *floral leaves* are sessile, small, and deeply laciniated. *Flowers* terminal, four or five, small, yellow. *Calyx* with a few longish scattered hairs. *Petals* ovato-oblong, somewhat clawed, standing apart from each other. *Pericarps* forming a nearly spherical fruit, smooth.

I do not know of any species from which the present one is not entirely distinct, although it has a considerable affinity, in its general habit, with the *Ran. Peruvianus* of Decandolle, and of Delessert's *Icones Selectæ*, t. 37. That species, however, has the root fibrillose at the summit, the leaves semi-orbicular (not rhomboid), the calyx very hairy, and the petals nearly orbicular.

DIADELPHIA HEXANDRIA.

CORYDALIS.

Calyx diphyllus. *Corolla* ringens. *Filamenta* duo, membranacea, singula antheris 3. *Capsula* siliquosa, polysperma.

Corydalis *canadensis*, scapo nudo simplici paucifloro, foliorum laciniis linearibus calcaribus duobus brevibus, stigmate porrecto quadrilobo.

Hab. Near Montreal.

Whole plant not more than 6–8 inches high, slender. *Root* tuberous and scaly. *Leaves* glaucous beneath, bipinnate, pinnæ pinnatifid, with the segments linear, rather obtuse, simple or again divided, especially the lower ones. *Scape* with a single raceme of about four flowers. *Pedicels* short, bracteated. *Flowers* purplish-red, much resembling those of *Corydalis formosa*, (*Diclytra* Dec.) *Stigma* 4-lobed.

I know not whether this be the Canadian variety of *Corydalis formosa*, which Mr Pursh says is "somewhat different in aspect from the Virginian plant, but not sufficiently so to constitute it a species;" but to me it appears most unquestionably distinct. It is altogether a very slender plant, the segments of the *leaves* peculiarly narrow, indeed quite linear. *Raceme* always simple, and the *stigma* not two-edged, as described by Gawler and Decandolle, but 4-lobed. In this last particular it comes near the *Fumaria eximia* of the Botanic Register. There, however, the whole plant is greatly larger, and more robust, the flowers are larger, the racemes compound, and the segments of the leaves very broad and incised. In many, but not in all points, this agrees with the *Diclytra tenuifolia* of Dec.; that, however, is an *Asiatic*, not as Pursh supposed, an *American* species.

SYNGENESIA POLYGAMIA ÆQUALIS.

BIDENS.

Calyx subæqualis calyculatus. *Corollulæ* rarius flosculo uno alterove radiante instructæ. *Receptaculum* paleaceum, planum. *Pappus* aristis duo seu quatuor, reflexis et erectis, scabris. *Semina* tetragona.

Bidens *Beckii*; foliis oppositis inferioribus capillaceo-multifidis, superioribus lanceolatis connatis acute serratis, floribus radiatis radio involucrum excedente.

B. *Beckii*, Torrey, in Sprengel's Neue Entdeckungen in ganzen Umfang der Pflanzenkunde, vol. ii. p. 135.

Hab. Stagnant waters, at the edge of the St Lawrence, near Montreal. Found by Dr Beck in similar situations near Schenectady, on the banks of the Missouri.

About a foot high, simple, or with very small and slender branches arising from the axils of the upper leaves. *Lower leaves* very multifid, capillary, as in *Ranunculus aquatilis*, upper ones about an inch and a half long, broadly lanceolate, attenuated at each extremity, deeply serrated. *Flowers* solitary at the extremity of the stem, rather large, yellow. *Radius* much longer than the involucre

GYNANDRIA MONANDRIA.

HABENARIA.

Corolla ringens. *Labellum* basi subtus calcaratum. *Glandulæ pollinis* nudæ distinctæ (loculis pedicellorum adnatis vel solutis distinctis).—*Brown.*

Habenaria *macrophylla*, labello lineari-elongato integerrimo, anthera basi utrinque producta, cornu germine duplo longiore, foliis binis planis elliptico-orbiculatis.

Hab. Moist shady woods, Island of Montreal. Very rare.

Of all the Orchideous plants which I have seen in North America, this is, without a question, the largest and most striking. It must rank next to *Habenaria orbiculata* (*Orchis* of Pursh and Nuttall), having, like it, two plane, orbicular, approaching to elliptical, *leaves*, which spring from immediately above the fasciculated root, and which, in this plant, are four times as large as those of *H. orbiculata*, measuring from six to eight inches in length, very thin and pellucid, beautifully marked with longitudinal and transverse veins. The *scape* is equally long in proportion, and is furnished with a few lanceolate scales. *Bracteas* similar to these, and shorter than the germen. *Flowers* large, white, resembling those of *H. bifolia*, and arranged in a lax spike of about five or six inches in length. The three *superior petals* are connivent, the *uppermost* is nearly orbicular, the others ovate, attenuated, the *two lateral* ones of the same shape, but much larger, reflexed, their bases decurrent with the *labellum*, which, standing forwards, is linear, as long as the germen, quite entire. *Germen* about an inch in length, slender, tapering down into a footstalk. *Column of fructification* very short. *Anther* large, broad, much like that of *H. bifolia*, but having the base of the cells remarkably apart, and elongated into two projecting horns. *Pollenmass* yellow, with a very long footstalk, and a jointed gland at the base. *Stigma* large, viscid.

MONŒCIA POLYANDRIA.

BETULA.

MAS. *Amentum* imbricatum, squamis peltatis trifloris. *Stamina* 10-12. FEM. *Squama* biflora. *Semen* unicum, alatum.

Betula *glandulosa*? ; caule punctato-glanduloso glabro, foliis obovatis brevi-petiolatis glabris serratis basi integerrimis, amentis cylindraceis pedunculatis, squamis trifidis.

B. *glandulosa*, Mich. Fl. Am. Bor. v. ii. p. 180. Willd. Sp. Pl. v. iv. p. 466. Pursh, Fl. Am. Sept. v. ii. p. 622.

Hab. Swamps about Lake Simcoe.

This plant quite agrees with the character of *B. glandulosa* of Michaux and Willdenow, but differs from that of Pursh in having decidedly pedunculated leaves, and pericarps with as broad a margin as those of *Betula pumila* figured by Jacquin.

CRYPTOGAMIA STACHYOPTERIDES.

Lycopodium.

Capsulæ reniformes uniloculares bivalves polyspermæ. *Semina* minutissima pulveriformia.

Lycopodium *integrifolium*; caule repente ramis adscendentibus, foliis sparsis linearibus acuminatis integerrimis piliferis incurvis, spicis pedunculatis elongato-cylindraceis ternatis, squamis rotundato-acuminatis dentatis.

Hab. About Montreal.

Very closely allied to *L. clavatum*, but differing in the quite entire leaves, which, moreover, are less densely imbricated, and in the rounder scales of the elongated ternate spikes.

The *L. tristachyum* of Pursh, is, according to Nuttall, " nearly allied to *L. clavatum*, but with entire leaves." Pursh himself, on the other hand, describes his plant as having erect stems, the branches compressed, the leaves lanceolate, acute, quadrifarious and appressed ; and he says that it is by him regarded as intermediate between *L. complanatum* and *L. sabinæfolium*. It cannot consequently be what Nuttall takes for the *tristachyum*, nor the individual now under consideration, which only differs from *L. clavatum* in the points which I have mentioned above. The true *tristachyum*, I may also observe, is a native of high mountains in Virginia.

CRYPTOGAMIA SCHISMATOPTERIDES.

Osmunda.

Capsulæ subglobosæ pedicellatæ striatæ semibivalves paniculatæ. *Indusium* nullum.

Osmunda *alata*; frondibus sterilibus ovato-lanceolatis pinnatis, pinnis pinnatifidis patentibus, stipite alato lanato, fructificantibus bipinnatis lanuginosis.

Hab. Canada,—Isle of Montreal and Grand River; but rare.

This plant attains to much larger dimensions than the *Osmunda cinnamomea* (*Claytoniana* of Linnæus and Smith), to which it is assuredly very closely allied, but from which it is distinguishable at once by the much broader outline, more patent pinnæ, and above all by the slender zig-zag winged stipes.

CRYPTOGAMIA FILICES.

ASPIDIUM.

Sori subrotundi sparsi. *Indusium* umbilicatum vel uno latere dehiscens.

Aspidium *Goldianum*; frondibus ovato-oblongis glabris pinnatis, pinnis lanceolato-acuminatis pinnatifidis, laciniis oblongis spinuloso-serratis, stipite paleaceo.

Aspidium *Goldianum*, Hooker's MSS

Hab. Near Montreal.

From one and a half to two feet in height. Allied to *Aspidium cristatum* more than to any other species in the genus; but abundantly distinguishable by the greater breadth of the frond, which gives quite a different outline, and by the form of the pinnæ, which are never *broader* at the base, but are, on the contrary, *narrower* than several of the segments just above them. These segments, too, are longer and narrower, slightly falcate, and those of the lowermost pinnæ are never lobed, but simply serrated at the margin. The serratures are likewise terminated by more decided, though short, spinules. The *fructifications* are central near the midrib, and this circumstance prevents the species from bearing, as it would otherwise do, no inconsiderable affinity to *A. marginale*.

Specimens of this plant, cultivated in the Botanic Garden at Glasgow, from roots which I brought from Canada, retain all the characters which I have above described.

ART. XVI.—*Description of a* TEINOSCOPE[*] *for altering the Lineal Proportions of Objects, with Observations on Professor* AMICI'S *Memoir on Telescopes without Lenses.* By DAVID BREWSTER, LL. D., F. R. S. Lond., & Sec. R. S. Ed.

THE Instrument which I propose to describe in the following Paper, was invented and constructed in its simplest form about the beginning of the year 1812, after I had determined, by numerous experiments, that *Colourless Refraction may be obtained by the action of two prisms of the same substance.* These Experiments, and this conclusion, were published in March 1813, in my *Treatise on New Philosophical Instruments* †.

The only practical purposes to which this singular principle seemed to be applicable, were the construction of an achromatic telescope, with lenses of the same glass, and the construction of an instrument for altering the lineal proportions of objects.

The method of imitating the action of the prisms by means of lenses, is described in the work already quoted (p. 400.), but from the want of a variety of deep meniscuses, I did not obtain a combination which removed entirely the *chromatic aberration*, although it was quite certain that this could be easily accomplished. A little reflection, indeed, convinced me, that it was impossible to remove the aberration of figure without multiplying the lenses;—that as one kind of aberration was corrected by the two lenses, another kind was created; and that I was therefore in search of a combination which required to be more complex in order to be of practical utility.

In the construction of the Teinoscope there were no practical difficulties. When the two prisms of crown-glass were put together, so as to give refraction without colour, it was obvious, that the lineal dimensions of objects were *extended* or *magnified* in the plane of refraction. I had therefore an instrument which magnified any object, such as the elevation of a building, &c. *in length*, while its *breadth* remained the same, or which altered the lineal proportions of objects. By moving one of the prisms in the plane of refraction, so as to go on each side of the achromatic position, the proportion of the length to the breadth of the object was altered, though the colour was of course not entirely corrected.

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[*] From τεινω *to extend*, and σκοπεω *to see*; an instrument for examining objects in a state of extension.

† Pages 383, 384; 399, 400.

In order to obviate this inconvenience, I contrived a compound instrument of four prisms, as represented in Plate X. Fig. 9., where AB is a prism with a variable refracting angle, as used by Clairaut for measuring dispersive powers. It consists of two prisms A, B, of the same material, united by two cylindrical surfaces *cd cf*, so that by the motion of the concave cylindrical surface of B upon the convex one of A, the two plane surfaces MN form different angles with one another. Another prism C, of the same glass, is placed as in the figure, so as to correct the colour of AB, when the inclination of M and N has its mean value.

If we now look at any object, through the faces *m n*, M, N, it will be quite free of colour, and its length (if in the plane of refraction,) will be magnified or extended, so that we can judge whether its form would be improved by varying its longitudinal dimensions. If we wish to examine its appearance when its length is made greater or less in proportion to its breadth, we have only to enlarge or diminish the inclination of the faces MN, and then correct the colour, by placing the prism C at a greater or a less distance from M. In this way we may ascertain the exact relation between the length and breadth of an object, which is most agreeable to the eye, in place of discovering it by a succession of designs.

As the effect of the different designs, however, possessing different ratios of length and breadth, could not be recollected so as to be brought into direct comparison, it became advisable to have two instruments adjusted to give the proportions which it was required to compare; and by combining the two instruments together, we obtained the additional advantage of enlarging the extending power of each instrument, when they were placed similarly or in the same plane; and of obtaining a variation in the breadth of the object when they were placed transversely or in rectangular planes. By such means we had it in our power to vary either the length or breadth of the object, and to produce within moderate limits any change that was required in the ratio of its lineal dimensions.

In constructing these instruments for actual use, it is not necessary that the prism C should be made of the same kind of glass as AB. The power of the instrument would be greatly increased, by making C of fluor-spar or rock-crystal, or the colourless topaz of New Holland *, on account of their low dispersive power. The reflection of light at the cylindrical surfaces of AB, may be removed by introducing a film of oil of the same refractive power as the glass, and the motions of the prisms N and C may be so connected, that the achromatic position for different angles of the variable prism may be obtained by turning a single screw nut.

Upon explaining the principles and application of the Teinoscope to an eminent artist, he seemed to consider it as too recondite for ordinary use, and I therefore did not publish any account of it along with the experiments on which it was founded. I am persuaded, however, that it will be found of great utility in painting, sculpture, architecture, and, in short, every branch of art, where it is requisite either to discover just proportions, or to copy those which nature has already displayed.

I have been induced to print the preceding account of the Teinoscope, in consequence of a paper which has been recently published by Professor Amici of Modena, in the nineteenth volume of the *Memorie della Societe Italiana*, entitled "*Memoir on the Construction of an Achromatic Telescope without lenses, and of a single Refracting Medium* †." This instrument is nothing more than the combination of prisms, with this difference only, that in my instrument the magnifying power may be varied at pleasure, whereas it remains always the same in Professor Amici's. It never occurred to me to call such an instrument a telescope, or to propose it for an opera-glass, as has been done by Professor Amici; and, in like manner, it does not seem to have entered his mind to use it for the purposes to which I applied it.

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* When quartz or topaz are used, the mean position of the refracted ray in the prism C, should coincide with the axis of the former, or one of the resultant axes of the latter.

† I have not seen the original Memoir, and am acquainted with its contents solely through a short notice in the *Quarterly Journal*, No. xxiv. p. 400. ; and a fuller analysis of it in the *Bibliotheque Universelle*, Nov. 1821, p. 174.—184.

With regard to the experiments and optical principles upon which the instrument is founded, it is necessary to state, that Professor Amici has published as new, in 1821, a series of experiments almost exactly the same as those which were published by me in 1813, in my *Treatise on New Philosophical Instruments.* "It has hitherto been believed, says this ingenious author, by natural philosophers, that the dispersion of colours is constant for the same refracting medium, or that a given refraction produced by the same substance is accompanied by a given dispersion; but I have found that the dispersion produced by more than one refraction is not by any means constant, but varies according to the various inclinations of the incident ray." In concluding his memoir, he goes on to observe, "That the ordinary theory of prismatic colours may easily shew us, that achromatic refraction does not necessarily require more than one refracting substance; and that though this theory has been deeply studied by so many distinguished opticians and mathematicians, from the time of Newton to the present day, yet *the property here described not only remained unknown,* but *would have* been reckoned impossible, if I had not discovered it in a series of experiments, which I made for a different purpose. We thus obtain an example, to add to so many others, that in physical science, *experiment is very often, and perhaps most commonly more successful than theory,* in developing all the circumstances which accompany a given pheuomenon."

Now, in the work already quoted, I have demonstrated by direct experiment, as well as by theory, *that the refraction is not constant for the same refracting medium;—that the dispersion varies with the inclination of the incident ray;—and that refraction without colour may be produced by two prisms of the same substance.* I have described, in short, in the fullest manner, that property, which, according to Professor Amici, has been hidden from philosophers from the days of Newton to the time of his discovering it. By examining Chap. I. of the fifth Book of the work already quoted, it will be seen, that I had pushed the inquiry still farther than the Italian philosopher: I have shewn by experiment, as well as by theory, that though the length of the spectrum is the same in the two prisms of the same substance, and with different refracting angles, yet the coloured spaces are not proportional; and that there is a *tertiary spectrum* produced in all such opposite refractions.

In the eulogium which Professor Amici has pronounced on the influence of experiment in physical researches, I heartily concur; but though an experiment directed to another object conducted him to the property in question, yet with me the case was quite the reverse; for I had deduced it solely from theory, as I have stated in my treatise, before I had made an experiment on the subject.

The coincidence between Professor Amici's researches and mine, must no doubt have been purely accidental, and it is not to be wondered at, that experiments recorded in the English language should be unknown in Italy a long time after they were made. I confess, however, it does surprise me, that in the very memoir of which we are speaking, Professor Amici has quoted, by page, my Treatise on New Philosophical Instruments, and that this quotation relates to the same subject, and is taken from the same chapter, which contains all my investigations respecting the production of colourless refraction by two prisms of the same substance.

Although I have felt it my duty to make this statement, I trust it will not be understood that I impute any blame to such a respectable and eminent philosopher as Professor Amici, and I have no doubt that he will be able to give a satisfactory explanation of any of those circumstances, which may appear to himself to require it.

ART. XVII.—*Description of the Slide of Alpnach.* By the late JOHN PLAYFAIR, Esq., Professor of Natural Philosophy in the University of Edinburgh, & Sec. R. S. E. [*] With Notes and Observations.

"ON the south side of Pilatus, a considerable mountain near Lucerne, are great forests of spruce fir, consisting of the finest timber, but in a situation which the height, the steepness, and the ruggedness of the ground, seemed to render inaccessible. They had rarely been visited but by the chamois hunters, and it was from them, indeed, that the first information concerning the size of the trees and the extent of the forest appears to have been received. These woods are in the canton of Unterwalden, one of those in which the ancient spirit of the Swiss republics is the best preserved; where the manners are extremely simple, the occupations of the people mostly those of agriculture, where there are no manufactures, little accumulation of capital, and no commercial enterprise. In the possession of such masters, the lofty firs of Pilatus were likely to remain long the ornaments of their native mountain.

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[*] From his *Works*, in four volumes octavo, just published, vol. i., Appendix No. 2. p. lxxxix. See this *Journal*, Vol. I. p. 193. and Vol. II. p. 110.

"A few years ago, however, Mr Rupp, a native of Wirtemberg, and a skilful engineer, in which profession he had been educated, indignant at the political changes effected in his own country, was induced to take refuge among a free people, and came to settle in the canton of Schwytz, on the opposite side of the lake of Lucerne. The accounts which he heard there of the forest just mentioned determined him to visit it, and he was so much struck by its appearance, that, long and rugged as the descent was, he conceived the bold project of bringing down the trees by no other force than their own weight into the lake of Lucerne, from which the conveyance to the German Ocean was easy and expeditious. A more accurate survey of the ground convinced him of the practicability of the project.

"He had by this time resided long enough in Switzerland to have both his talents and integrity in such estimation, that he was able to prevail on a number of the proprietors to form a company, with a joint stock, to be laid out in the purchase of the forest, and in the construction of the road along which it was intended that the trees should slide down into the lake of Lucerne, an arm or gulph of which fortunately approaches quite near to the bottom of the mountain. The sum required for this purpose was very considerable for that country, amounting to nine or ten thousand pounds; three thousand to be laid out on the purchase of the forest, from the community of Alpnach, the proprietors of it, and the rest being necessary for the construction of the singular railway by which the trees were to be brought down. In a country where there is little enterprise, few capitalists, and where he was himself a stranger, this was not the least difficult part of Mr Rupp's undertaking.

"The distance which the trees had to be conveyed is about three of the leagues of that country, or, more exactly, 46,000 feet. The medium height of the forest is about 2500 feet: (which measure I took from General Pfyffer's model of the Alps, and not from any actual measurement of my own). The horizontal distance just mentioned, when reduced to English measure, making allowance for the Swiss foot, is 44,252 feet, eight English miles and about three furlongs. The declivity is therefore one foot in 17.68; the medium angle of elevation 3° 14′ 20″.

"This declivity, though so moderate on the whole, is, in many places, very rapid; at the beginning the inclination it is about one-fourth of a right angle, or about 22° 30′; in many places it is 20°, but nowhere greater than the angle first mentioned, 22° 30′. The inclination continues of this quantity for about 500 feet, after which the way is less steep, and often considerably circuitous, according to the directions which the ruggedness of the ground forces it to take.

"Along this line the trees descend, in a sort of trough, built in a cradle form, and extending from the forest to the edge of the lake. Three trees, squared, and laid side by side, form the bottom of the trough; the tree in the middle having its surface hollowed, so that a rill of water received from distance to distance, over the side of the trough, may be conveyed along the bottom and preserve it moist. Adjoining to the central part, (of the trough,) other trees, also squared, are laid parallel to the former, in such a manner as to form a trough, rounded in the interior, and of such dimensions as to allow the largest trees to lie, or to move along quite readily. When the direction of the trough turns, or has any bending, of which there are many, its sides are made higher and stronger, especially on the convex side, or that from which it bends, so as to provide against the trees bolting or flying out, which they sometimes do, in spite of every precaution. In general, the trough is from five to six feet wide at top, and from three to four in depth, varying, however, in different places, according to circumstances.

" This singular road has been constructed at considerable expence; though, as it goes, almost for its whole length, through a forest, the materials of construction were at hand, and of small value.* It contains, we are told thirty thousand trees; it is, in general, supported on cross timbers, that are themselves supported by uprights fixed in the ground; and these cross timbers are sometimes close to the surface; they are occasionally under it, and sometimes elevated to a great height above it. It crosses in its way three great ravines, one at the height of 64 feet, another at the height of 103, and the third, where it goes along the face of a rock, at that of 157; in two places it is conveyed under ground. It was finished in 1812.

" The trees which descend by this conveyance are spruce firs, very straight, and of great size. All their branches are lopped off; they are stripped of the bark, and the surface, of course, made tolerably smooth. The trees, or logs, of which the trough is built, are dressed with the axe, but without much care.

" All being thus prepared, the tree is launched with the root end foremost, into the steep part of the trough, and in a few seconds acquires such a velocity as enables it to reach the lake in the short space of six minutes; a result altogether astonishing, when it is considered that the distance is more than eight miles, that the average declivity is but one foot in seventeen, and that the route which the trees have to follow is often circuitous, and in some places almost horizontal.

" Where large bodies are moved with such velocity as has now been described, and so tremendous a force of course produced, every thing had need to be done with the utmost regularity; every obstacle carefully removed that can obstruct the motion, or that might suffer by so fearful a collision. Every thing, accordingly, with regard to launching off the trees, is directed by telegraphic signals. All along the slide, men are stationed, at different distances, from half a mile to three quarters, or more, but so that every station may be seen from the next, both above and below. At each of these stations, also, is a telegraph, consisting of a large board, like a door, that turns at its middle on a horizontal axle. When the board is placed upright, it is seen from the two adjacent stations; when it is turn ed horizontally, or rather parallel to the surface of the ground, it is invisible from both. When the tree is launched from the top, a signal is made, by turning the board upright; the same is followed by the rest, and thus the information is conveyed, almost instantaneously, all along the slide, that a tree is now on its way. By and bye, to any one that is stationed on the side, even to those at a great distance, the same is announced by the roaring of the tree itself, which becomes always louder and louder; the tree comes in sight when it is perhaps half a mile distant, and in an instant after shoots past, with the noise of thunder and the rapidity of lightning. As soon as it has reached the bottom, the lowest telegraph is turned down, the signal passes along all the stations, and the workmen at the top are informed that the tree has arrived in safety. Another is set off as expeditiously as possible; the moment is announced, as before, and the same process is repeated, till all the trees that have been got in readiness for that day have been sent down into the lake.

"When a tree sticks by accident, or when it flies out, a signal is made from the nearest station, by half depressing the board, and the workmen from above and below come to assist in getting out the tree that has stuck, or correcting any thing that is wrong in the slide, from the springing of a beam in the slide; and thus the interruption to the work is rendered as short as possible.

"We saw five trees come down; the place where we stood was near the lower end, and the declivity was inconsiderable, (the bottom of the slide nearly resting on the surface,) yet the trees passed with astonishing rapidity. The greatest of them was a spruce fir a hundred feet long, four feet in diameter at the lower end, and one foot at the upper. The greatest trees are those that descend with the greatest rapidity; and the velocity as well as the roaring of this one was evidently greater than of the rest. A tree must be very large, to descend at all in this manner; a tree, Mr Rupp informed us, that was only half the dimensions of the preceding, and therefore only an eighth part of its weight, would not be able to make its way from the top to the bottom. One of the trees that we saw broke by some accident into two; the lighter part stopped almost immediately, and the remaining part came to rest soon after. This is a valuable fact: it appears from it that the friction is not in proportion to the weight, but becomes relatively less as the weight increases, contrary to the opinion that is generally received *.

" In viewing the descent of the trees, my nephew and I stood quite close to the edge of the trough, not being more interested about any thing than to experience the impression which the near view of so singular an object must make on a spectator. The noise, the rapidity of the motion, the magnitude of the moving body, and the force with which it seemed to shake the trough as it passed, were altogether very formidable, and conveyed an idea of danger much greater than the reality. Our guide refused to partake of our amusement; he retreated behind a tree at some distance, where he had the consolation to be assured by Mr Rupp, that he was no safer than we were, as a tree, when it happened to bolt from the trough, would often cut the standing trees clear over. During the whole time the slide has existed, there have been three or four fatal accidents, and one instance was the consequence of excessive temerity.

" I have mentioned that a provision was made for keeping the bottom of the trough wet; this is a very useful precaution; the friction is greatly diminished, and the swiftness is greatly increased by that means. In rainy weather the trees move much faster than in dry. We were assured that when the trough was every where in its most perfect condition, the weather wet, and the trees very large, the descent was sometimes made in as short a time as three minutes.

" The trees thus brought down into the Lake of Lucerne are formed into rafts, and floated down the very rapid stream of the Reuss, by which the lake discharges its waters first into the

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* This fact has been long known from the launching of vessels. " Shipbuilders," says M. Bossut, " give only a slope of ten or twelve lines *per* foot to the planes on which vessels are launched." " This declivity, which is sufficient to put large masses in motion, in spite of the resistance of friction, is too small for weights of moderate magnitude. If we wish, therefore, to suppose that the friction of two bodies are proportioned to their weight, it is necessary that the difference between their weights should not be very great."—Ed.

Aar, and then into the Rhine. By this conveyance, which is all of it in streams of great rapidity, the trees sometimes reach Basle, in a few days after they have left Lucerne; and there the immediate concern of the Alpnach company terminated. They still continue to be navigated down the Rhine in rafts to Holland, and are afloat in the German Ocean in less than a month from having descended from the side of Pilatus, a very inland mountain, not less than a thousand miles distant. The late Emperor of France had made a contract for all the timber thus brought down.

"From the phenomena just described, I have deduced several conclusions, of which at present I can only give a very general account, without entering into any of the mathematical reasonings on which they rest.

"1. The rapidity of the descent is so extraordinary, it is so much greater than any thing that could have been anticipated, exceeding that of a horse at full speed, nearly in the ratio of 3 to 2, that the account seems to tread on the very verge of possibility, and to touch the line that divides between what may, and what cannot exist. The same question, therefore, I have no doubt, has occurred to many that occurred to myself, when I first heard of this extraordinary phenomenon.

"Is it possible that even if there were no friction, and if a body was accelerated along the line of swiftest descent, from a point 2500 feet above another, and horizontally distant from it by 44,009, that it could arrive at that lower point in three or even in six minutes? This was the first question that occurred to me, and at a distance from books as I was then, and in no condition to undertake any nice or difficult calculation, I could only satisfy myself by a rude approximation, that there was nothing in the reported circumstance that was without the limits of possibility. Had the result of the calculation been contrary, I should not only have disbelieved the report, but I should have doubted the testimony of my own senses.

"From a more accurate calculation I find that if no friction nor resistance took place, and if the moving body was allowed to take its flight in the line of the swiftest descent, that it would do so in less than sixty-six seconds. This is the minimum then of time, and we may rest assured, while the laws of nature continue the same that they are now, that no body, in the circumstances just described, can perform its journey in less time than the above.

"But though the descent of the trees at Alpnach contains nothing inconsistent with the acceleration of bodies by gravity, it is not to be reconciled with the notions concerning friction, that are usually received even in the scientific world.

"It is common to consider friction as a force bearing a certain proportion to the weight of the body moved, and as retarding the body by a force proportional to its weight, amounting to a fourth or fifth part, or when least to a tenth or twelfth part of gravity. A body, therefore, that was descending along an inclined plane, would be accelerated by its own gravity, minus the force of friction, a constant force that increased in proportion to the body.

"Now, in the present case, it will soon appear that the retardation is vastly less than would arise from any of these suppositions.

"Supposing it to be true, that friction in a given instance (the surface, the inclination, and the weight, being all given) acts as a uniformly retarding force, I have found that a body sliding along an inclined surface, under the acceleration of gravity, and the retardation of friction, will be accelerated, so that it will have at every point the velocity that would be acquired by falling by its own gravity from a line inclined to the horizon, that is drawn from the point where the body began to move, and that makes with the horizon an angle, the tangent of which is the fraction, that denotes the ratio of friction to gravity. The velocity of the moving body is therefore as the square root, of the portion of a vertical passing through the body, and reaching up to the line just mentioned, or the line of no acceleration.

"As the trees at Alpnach enter the lake with a considerable velocity, it is evident that the line of no acceleration, drawn from the top of the slide, does not reach the ground at the point where the slide ends, but is then still considerably above the surface; the tangent, therefore, of the angle which that line makes with the horizon, is much less than $\frac{1}{17}$. There is reason to think that it does not in reality amount to $\frac{1}{3}$ of this, and is therefore less than $\frac{1}{50}$. It follows, then, that the friction that trees suffer in the slide is less than one-fiftieth of their weight.

"Now, from what can we suppose the small proportion that friction in this instance, bears to the weight, to arise? It is not that the surfaces have a great smoothness or a fine polish. The logs that form the trough are coarsely dressed with the adze, and I observed that there was not even the precaution taken of making the grain of the wood lie downward, or toward the declivity. It was so in the tree, but not in the trees which composed the slide. It is not that any lubricating substance, oil, grease, soap, or black-lead, is interposed between their surfaces. Water is the only substance of this kind that is applied. We have fir rubbing on fir, which is supposed a case remarkably unfavourable to the diminution of friction. It can only arise, therefore, from a principle that some mechanical writers have suspected to exist, but which was never before, I think, proved by the direct evidence of facts, namely, that the force of friction does not increase in the proportion of the weight of the rubbing body, so that heavy bodies are, in reality, less retarded in their motion on an inclined surface than lighter bodies. Thus, the whole of the phenomena I have been describing, tend to prove, especially the fact I mentioned, that heavy trees made their way more easily than light ones, and that a tree must be of a certain magnitude to make its way to the bottom. Friction, therefore, does not bear even in the same materials a given ratio to the weight, but a ratio that evidently decreases as the weight increases; so that, in a fir of ordinary size it is $\frac{1}{10}$, or $\frac{1}{20}$, in one of 100 feet in length it is between $\frac{1}{50}$ and $\frac{1}{60}$. According to what law this change takes place, it would be most useful to investigate; it is an inquiry for those engineers who have strong machinery and great power ready at command.

"I must observe also, that I strongly suspect that friction diminishes with the velocity of the moving or sliding body. That it passes all at once when a body begins to move, to be only half of what it was when the body was at rest, is quite certain, and is proved by many experiments. It seems to me not unlikely that the same progress continues as the motion becomes greater. Perhaps in as much as friction is concerned, the pressure is lessened by the velocity, and the poet was not so far mistaken as he is generally supposed to be, when he said of his heroine

> Illa vel intactæ segetis per summa volaret
> Gramina, nec teneras cursu læsisset aristas.

However that be, we have a strong example here of the danger of concluding in many of the researches of mechanics, from experiments made on a small scale to the practice that is to be proceeded on in a great one. It requires some attention to enable us to discriminate between the cases where we can safely proceed from the small to the great, and those in which we cannot. A man, from finding that bodies of a pound or half a pound are in equilibrio when their distances from the fulcrum are inversely as their weights, might, without danger of error, transfer the conclusion to weights of hundreds of tons, or to whole planets, were it possible to make the experiment on so large a scale. But when he finds that the friction of a body of a pound, or a hundred weight, is one-fourth of the weight, he cannot, with equal safety, presume that the same will hold when bodies of immense weight and size come to rub against one another. There are many other cases of the same kind. In general, when our experiments lead to the knowledge of a fact and not of a principle, there is caution required in extending the conclusions beyond the limits by which the experiments have been confined. This is the case with the experiments on friction, where we know only facts, and have no principle to guide us; that is, we have not been able to connect the facts with any of the known and measurable properties of body. In the case of the lever, we have connected the fact with the inertia of matter, and the equality of action and reaction. We have, therefore, a right to repose confidence on the one, when extended, though not on the other.

"That friction belongs to the cases in which great caution is necessary in extending the conclusions of experiments, is indeed most strongly evinced by the operations that have now been described, the result of which is such as could not have been anticipated from those experiments. The danger here, however, is quite of an opposite kind from that which commonly takes place in such instances. The experiments on the small scale, usually represent the thing as more easy than it is, upon the great, and engage us in attempts that prove abortive, and are followed by disappointments and even ruin. In the present case, the experiments on the small scale represent the thing as more difficult than when tried on a great one it is found to be, and would lead us, by an error, the direct opposite of the last, to conclude things to be impracticable that may be carried into effect with ease. Had the ingenious inventor of the slide at Alpnach been better acquainted with the received theories of friction, or the experiments on which they are founded, even those that are the best, and on the greatest scale, such as those of another most skilful engineer, M. Coulomb, or had he placed more faith in them, he would never have attempted the great work in which he has so eminently succeeded."

Observations on the preceding Paper.

It is much to be regretted that the editor of Professor Playfair's works did not terminate the preceding interesting and valuable paper with the second paragraph of p. 345. In the succeeding pages, the distinguished author maintains, 1. That the phenomena of the slide are incompatible with the recent theories of friction; 2. That Mr Rupp, the engineer, would never have executed that great work, had he been acquainted either with these theories, or with the experiments of Coulomb. 3. That heavy bodies are less retarded by friction on an inclined plane than lighter bodies; and, 4. That he strongly suspects that friction diminishes with the velocity of the moving or sliding body. The two first of these conclusions are evidently incorrect, and founded on an oversight of the author; and the two last have long formed a part of the received theories on friction, and have been deduced from actual experiment.

On the evening upon which Professor Playfair read this paper to the Royal Society, the writer of this note reminded him of Coulomb's beautiful discovery, that when the touching surfaces were small compared with the pressure, (which was obviously the case with the trees of Alpnach,) the *friction diminished as the velocity increased*; and in our brief notice of the paper in Vol. I. p. 193. of this Journal, published during Mr Playfair's life, we remarked, " that the very singular phenomena described in Mr Playfair's paper, arose from the diminution of friction in consequence of an increase of velocity, and may be regarded as an experimental confirmation, on a large scale, of the ingenious views of Coulomb." That Mr Playfair intended to avail himself of these hints, was quite certain, as he repeatedly declined to print the paper in the Transactions of the Royal Society of Edinburgh, till he had matured his views on the subject.

M. Bossut, so early as the year 1763, had discovered that the friction was always a less part of the pressure in large masses than in small ones; and had thus in some measure anticipated the discovery of Coulomb. Some time afterwards M. Lambert observed, that the resistance generated by the friction of the communicating parts of an undershot corn-mill, combined with that which arises from the grain between the millstones, always diminished when the velocity was increased; and Mr Southern of Soho, found, by experiments on heavy machinery, that the friction never exceeded $\frac{1}{40}$th of the pressure, which is even less than its average amount in the slide of Alpnach.

We have been induced to make these observations, in order to shew that the phenomena of the slide of Alpnach were in every respect consistent with previous theories and experiments, and to prevent any doubtful opinions from being propagated under the sanction of a distinguished name.—ED.

ART. XVIII.—*Account of Meteorological Observations made in North America by Dr* HOLYOKE *and Professor* DEWEY.

THE new volume of the Memoirs of the American Academy of Arts and Sciences, contains three series of very interesting thermometrical observations, of which we propose to give a brief abstract.

1. *Dr* HOLYOKE'S *Observations at Salem, during a period of Thirty-three Years.*

The first series was made at Salem, in Massachussets, by Dr Holyoke, with Fahrenheit's thermometer, and was continued without interruption for thirty-three years, from 1786 to 1818 inclusive. The observations were made *four times* a-day, at 8h A. M., at noon, at sunset, and at 10h P. M.

The following Table contains the mean monthly and annual results, deduced from more than 48,000 observations.

Longitude of Salem, - 4° 43′ 37″ West of Greenwich
Latitude, - - 42° 33′ 30″ North.

For 33 Years.		For 33 Years.			
January,	25°.439	Mean of 8h A. M.	46°.426	Hottest day in	
February,	26.963	Mean of Noon,	55 47	33 years,	101°
March,	35.321	—— of Sunset,	48.563	Coldest day,	—11°
April,	46.108	—— 10h P. M.	44.316	Hence the greatest range is	112°
May,	56.727				
June,	67.013	Mean of Winter,	27.502	Hottest year,	1793
July,	72.011	—— — Spring,	46.05	Coldest year,	1812
August,	70.522	—— — Summer,	69.84		
September,	62.702	—— — Autumn,	51.308		
October,	51.148				
November,	40.014	Mean of Spring and Autumn,	48°.679		
December,	30.179	—— — Winter and Summer,	48.671		
Annual Mean of 33 Years,	48.678				

The mean temperature of the parallel of 42° 33′ being thus established by the most rigorous and long continued observation to be 48°.68 *, it will be interesting to compare it with a similar parallel in the Old World. Rome, which is placed in Lat. 41° 53′, approaches within 40′ of the parallel of Salem, and will therefore serve for making the comparison :

	Lat.	
Mean Temperature of *Salem*, in the New World,	42° 33′	48°.68
Mean Temperature of *Rome*, in the Old World,	41 53	60.44
	Difference.	11°.76

This result will, we trust, set at rest for ever the ridiculous opinion that the Old and the New World have the same average temperature.

It is worthy of remark, that Dr Holyokes's observations give the mean temperature of Salem considerably less than that of

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* Dr Holyoke, and other scientific individuals of the American Academy, are of opinion that this result errs rather in *excess* than in *defect*, in consequence of the heat reflected upon the thermometer from the north wall of the street.—See *Memoirs of the Amer. Acad.* vol. iv. p. 386.

Cambridge in Massachussets, which is nearly in the same parallel, thus:

Mean Temperature of Salem,	-	42° 33′	- 48°.68
Mean Temperature of Cambridge, U. S.		42 25	- 50.36
		Difference,	1°.68

As the observations at Cambridge were made only for *two* years, the mean temperature of the parallel of 40°, which Humboldt makes 54°.50, must now be reduced considerably.

2. *Professor* Dewey's *Thermometrical Observations for Five Years, at Williamstown, Massachussets.*

These observations were made at 7h A. M. 2h P. M. and 9h P. M.

Longitude of Williamston, -	73° W.
Latitude of ditto, - -	42° 30′ N.
Height of ditto above the tide-water of the Hudson at Troy, - - -	1000 feet.

	1816,	1817,	1818,	1819,
January, -	21°.03	20°.81	20°.26	28°.14
February, -	25.15	15.10	14.94	27.73
March. -	29.35	28.55	31.23	25.86
April, -	42.68	43.77	39.09	42.19
May, -	52.81	54.31	53.59	55.30
June, -	60.64	59.57	68.50	67.22
July, -	64.64	67.40	71.25	70.31
August, -	64.89	66.47	65.95	68.99
September, -	55.02	58.68	55.60	64.01
October, -	48.42	45.06	48.11	46.31
November,	39.73	38.79	39.75	38.21
December,	23.71	27.02	22.03	25.07
Annual Means,	44°.35	43°.79	44°.19	46°.61

Mean Temperature for Four Years, - - - - -	44°.73
Mean Temperature of Three Springs for 1816, - -	47°.20
——————— 1817, - -	47.11
——————— 1818, - -	47.12
Mean Temperature of Springs,	47°.21

	Inch
Mean of Barometer, 1818, - - - - -	29.14
——————— 1819, - - - - -	29.18

3. *Experiments for ascertaining which three Hours of the Day give a Mean nearest the True Mean Temperature.*

Professor Dewey undertook a series of observations in the years 1816 and 1817, in order to ascertain the *three* times of the day when observations should be made with the thermometer, in order to obtain a mean nearest to the true mean temperature. In order to do this, he observed the thermometer twenty-four times each day, or once every hour, during thirty days, at different times of the year, and he obtained the following results:

Mean of 24 observations during each hour of 30 days, -	41°.50
—— of 7^{h} A. M. and 2^{h} A. M. - - - - -	42.47
—— of highest and lowest, - - - - - -	42.66
—— do. do. means, - - - - - - -	42.69
—— about sunrise and sunset, - - - -	40.88
—— of 8^{h} A. M. 1^{h} P. M. and 6^{h} P. M. * - -	45.00

Hence Professor Dewey concludes that 7^{h} A. M., 2^{h} P. M. and 9^{h} P. M. are the best three hours of observation.

With the interesting data furnished by Professor Dewey, we were naturally anxious to ascertain whether or not the hours of 10^{h} A. M. and 10^{h} P. M., as recommended by the Meteorological Committee of the Royal Society of Edinburgh, and first employed and suggested by the Reverend Robert Gordon, as an approximate result to the mean of the highest and lowest during the day, were such as to

The following are the mean of the *five* series of observations made by Professor Dewey:

	Mean of 10^{h} A. M. and 10^{h} P. M.	Mean of 24 Observations, or one every hour.
1816, March 23.—29. -	37°.67	39°.05
April 1.—5. -	41.48	41.76
July 23.—[illegible]. -	63.46	47.69
October 28.—Nov. 1.	48.55	64.36
1817, Jan. 6.—Feb. 6. -	16.10	14.66
Mean of 2 Observations at 10^{h} A. M. and 10^{h} P. M.	41°.45	Mean of 24 Observations, 41°.50

This result must be considered as a very extraordinary one, as the mean of 10^{h} A. M. and 10^{h} P. M. is within $\frac{5}{100}$ths of a degree of the true mean, deduced from 24 observations; and hence we are led to a conclusion, which we consider as of very great importance in meteorology; *that the mean of* TWO *observations at 10ʰ A.M. and 10ʰ P.M. is not only nearer than any two observations to the mean of the* maximum *and* minimum, *as Mr Gordon found it to be; but that it is nearer than the mean of the* MAXIMUM *and* MINIMUM *themselves to the true temperature of the day, and even nearer than the mean of any* THREE *observations.*

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* Hours proposed by the Philosophical Society of New York.

If these remarks should ever meet the eye of Professor Dewey, we trust he will adopt the observations of 10ʰ A. M. and 10ʰ P. M., as not only saving the trouble of 365 observations in the year, but as giving the most correct mean result.

As it would be desirable to possess a series of observations made in Scotland for every hour of the day, for a small number of days, we beg leave earnestly to suggest such a series of experiments to some of those active meteorologists who have undertaken to keep regular registers of the thermometer in Scotland.

D. B.

ART. XIX.—*Account of Natural Ice-Houses in Connecticut.* *By* BENJAMIN SILLIMAN, Professor of Mineralogy in Yale College *.

THAT ice is perpetual in some climates is notorious. That it is so even in those of the Torrid Zone, upon mountains which rise to the height of three miles, is also well known. It is, however, a rare occurrence, even in cold climates, that ice is perennial on ground which possesses no more than the common elevation.

An instance of this kind has, however, recently come to our knowledge. It exists in the State of Connecticut, in the township of Meriden, mid-way between Hartford and Newhaven. This natural ice-house is situated in about 42° of north latitude, nearly twenty miles from the sea, and at the elevation of probably not more than two hundred feet above its level.

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* From the *American Journal of Science*, vol. iv. p 174.

The country is a part of the secondary trap region of Connecticut, and is marked by numerous distinct ridges of greenstone, which present lofty mural precipices, and, from their number, contiguity, and parallelism, they often form narrow precipitous defiles, filled more or less with fragments of rocks, of various sizes, from that of a hand stone to that of a cottage. These fragments are the detritus or debris of these mountains, and every one in the least acquainted with such countries, knows how much they always abound with similar ruins.

In such a defile, the natural Ice-House in question is situated. On the south-western side there is a trap ridge of naked perpendicular rock, which, with the sloping ruins at the base, appears to be four hundred feet high; the parallel ridge which forms the other side of the defile is probably not above forty feet high, but it rises abruptly on the eastern side, and is covered on the other by wood, which occupies the narrow valley also. This valley is moreover choked, in an astonishing degree, with the ruins of the contiguous mountain-ridge, and exhibits many fragments of rock which would fill a large room. As the defile is very narrow, these fragments have in their fall been arrested here, by the low parallel ridge, and are piled on one another in vast confusion, forming a series of cavities which are situated among and under these rocks. Many of them have reposed there for ages, as appears from the fact that small trees, (the largest that the scanty soil, accumulated by revolving centuries, can support), are now growing on some of these fragments of rock. Leaves also, and other vegetable remains, have accumulated among the rocks and trees, and choked the mouths of many of the cavities among the ruins. This defile, thus narrow, and thus occupied by forest, and by rocky ruins, runs nearly north and south, and is completely impervious to the sun's rays, except when he is near the meridian. Then, indeed, for an hour, he looks into this secluded valley; but the trees, and the rocks, and the thick beds of leaves, scarcely permit his beams to make the slightest impression.

It is in the cavities, beneath the masses of rocks already described, that the ice is formed. The ground descends a little to the south, and a small brook appears to have formed a channel among the rocks. The ice is thick, and well consolidated, and its gradual melting in the warm season, causes a stream of ice-cold water to issue from this defile. This fact has been known to the people of the vicinity for several generations, and the youth have, since the middle of the last century, been accustomed to resort to this place in parties, for recreation, and to drink the waters of the cold-flowing brook.

It was on the 23d of last July (1821), in the afternoon of a very hot day, when the thermometer was probably as high as 85° Fahr., that, under the guidance of Dr Hough, we entered this valley. After arriving among the trees, and in the immediate vicinity of the ice, there was an evident chilliness in the air; and, very near the ice, the air was (compared with the hot atmosphere which we had just left), rather uncomfortably cold. The ice was only partially visible, being covered by leaves, and screened from view by the rocks; but a boy descending with a hatchet, soon brought up large firm masses. One of these, weighing several pounds, we carried twenty miles, to Newhaven, where it was exhibited to various persons, and some of it remained unmelted during two succeeding nights; for it was in being on the morning of the third day.

The local circumstances which have been detailed, will probably account for this remarkable *locality* of ice, and scarcely need any illustration or comment.

This is not the only instance of the kind existing among the trap rocks of Connecticut. There is a similar place seven miles from Newhaven, near the Middletown Road, in the parish of Northford, and township of Branford. The ice here also, (as we are assured), endures the year round. This place we have not visited, but we are assured that it is at the bottom, or on the declivity of a trap ridge. Several years age, we had the ice of this place brought to us into Newhaven, in the hottest weather of mid-summer. Like that of Meriden, it is very solid; but, like that also, it is soiled with leaves and dirt; and although it is unfit to be put into liquids, which are to be swallowed, it is as good as any ice for mere cooling.

It is perhaps worthy of being mentioned, that an artificial ice-house, within the knowledge of the writer, is situated on the top of a ridge of trap in Connecticut. The excavation was made simply, by removing the loose pieces of trap rock, which are here piled in enormous quantities, but composed of fragments of very small size. These loose pieces of stone, with the air in the cavities, are better non-conductors of heat than the ground which usually surrounds ice-houses; for the ice keeps remarkably well in this elevated ice-house. Perhaps this will aid us also in explaining the phenomena of the natural ice-houses that have been mentioned.

It may not be useless, before dismissing this article, to mention, that the roof of an ice-house should be painted white, and that it should be thatched with straw, beneath the ordinary wood-roof. The surface of the roof thus becomes reflecting, and non-absorbing, and the substance non-conducting in relation to heat. We can speak from experience of the efficacy of this arrangement.

Art. XX.—*Description of a New and Portable Æthrioscope.* By John Murray, Esq. F. L. S., M. W. S., and Lecturer on Chemistry, &c.

The Æthrioscope which I propose to describe in the following paper, is not only extremely sensible, but is also remarkable for the simplicity of its construction, and for its perfect portability.

It consists of a lower glass-ball B, Plate X. Fig. 10., reposing in the cavity of a stand. This ball contains alcohol or æther tinged red, and is only about half filled with fluid. A glass-stem CD, screws into this ball, or is adapted to it by grinding, and its lower orifice passes into the coloured fluid, say ¾ths of its depth. This hollow glass-tube, into which the tinged liquid ascends, carries the scale as represented in the figure. The hollow brass spherical cup A, screws on at top, and appears in the sketch protected by its lid. The small glass-ball *b*, which surmounts the tube, is screwed on in the cup, or ground to fit its extremity. The instrument is then complete, and so soon as the lid is removed, and the sentient-ball included in the cup, exposed to the sky, the coloured fluid will rise in the tube, and its height be determined by the attached scale. On replacing the lid, the effect is extinguished. The radiation of caloric from the surface of the sentient-ball to the heavens is thus clearly indicated.

When the observation is completed, the upper glass-ball is taken off, and thereafter the spherical cup. The tube with its scale is then removed from the lower ball, which last being secured by a stopper, the whole is put up in a small case.

It is evident that the Æthrioscope now described, is easily converted into a Hygrometer:—for this purpose it is merely necessary to unscrew the hollow spherical cup, and cover the sentient ball with muslin or a bit of tissue-paper, and, the instant this is moistened, the coloured fluid will begin to ascend from below.

By merely coating the lower ball with China ink, or gilding it, the instrument becomes either a Photometer or a Pyroscope.

ART. XXI.—*Description of a Copper Battle-Axe found in Ratho Bog, and now in the possession of* ANDREW WADDELL, Esq. F. R. S. E. *

IN carrying the Union Canal through Ratho Bog, on the estate of Bonnington, and county of Mid-Lothian, it was necessary to execute some very deep cutting at Wilkie's Hill, at the head of the bog.

After descending through *nine* feet of *moss*, and *seven* feet of sand, the workmen came to the hard, black till-clay; and at the depth of *four* feet below its junction with the stratum of sand, they found the head of a Battle-Axe, of an unusual kind.

It consists wholly of pure copper. Its length is *four inches five-tenths and a half.* Its *maximum* breadth, or the chord of its circular cutting edge, is *three inches;* and its least breadth *two inches.* Its cutting edge is composed as it were of two edges of different inclinations; and as it has no provision made in the metal for the reception of a handle, it must have been fixed by a string, or some other means, into the cleft at the end of the handle, like the Steinbartes of Shetland.

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* Read before the Society of Scottish Antiquaries, Feb. 11. 1822.

The representation of it which is given in Plate VIII. Fig. 14. is reduced to about one-third of its real size.

Among the great number of ancient axes in the Museum of the Society of Scottish Antiquaries, there are very few which resemble the present one in shape and structure; and there is not one of them which consists of copper, all of them being made of a kind of bronze or bell-metal.

Out of five of these axes which have a resemblance to the one found in Ratho Bog, three were found in Scotland. The first, which was discovered at Wauchton in East Lothian, was presented to the Society by Mr George Rennie of Wauchton, without any description. Another, of less size, was presented by Mr Graham of Gartmore; and the third, of intermediate magnitude, was found in one of the fields where the battle of Largs was fought. It has several deep spherical hollows in it, apparently produced by the action of some corroding material.

The other two axes were found in Ireland. They were presented to the Society by the Reverend Edward Ledwich, Vicar of Aghaboe, and are described and represented in the *Collectanea de Rebus Hibernicis*, No. xiii.

Although all these have a general likeness to the copper one, yet they differ from it in many particulars. They all taper much more rapidly, and their smaller ends are all less than 1¼ inch in breadth, being only two-thirds of that of the copper axe, although their lengths vary from 5 to 7½ inches.

The axe discovered in the bog at Ratho possesses a peculiar interest, from the depth at which it was found. It must have been deposited along with the blue clay, prior to the formation of the superincumbent stratum of sand; and must have existed before the diluvial operations by which that stratum was formed. This opinion of its antiquity is strongly confirmed by the peculiarity of its shape, and the nature of its composition.

D. B.

EDINBURGH,
February 1822.

ART. XXII.—*Meteorological Observations made at the Radcliffe Observatory, Oxford, in the Years* 1816, 1817, 1818, 1819, 1820, 1821. Communicated by the Rev. A. ROBERTSON, F. R. S. Savilian Professor of Astronomy at Oxford.

THE following Table shews the mean degree of cold and heat for every month in the years 1816, 1817, 1818, 1819, 1820 and 1821, at the Radcliffe Observatory, Oxford, Lat. 51° 45′ 39″.5. The degrees of cold and heat were ascertained by a thermometer of Six's construction.

Month.	1816.			1817.			1818.			1819.			1820.			1821.		
	Lowest	Highest.	Mean.	Lowest.	Highest.	Mean.	Lowest.	Highest.	Mean.	Lowest.	Highest.	Mean.	Lowest.	Highest.	Mean.	Lowest.	Highest.	Mean.
January,	34	39	36.5	34	44	39	37	43	40	33	45	39	24	36	30	33	41	37
February,	29	42	35.5	38	48	43	32	40	36	34	43	38.5	31	41	36	29	39	34
March,	33	45	39	35	49	42	35	46	40.5	38	48	43	34	47	45.5	36	49	42½
April, -	35	52	43.5	34	53	43.5	40	51	45.5	41	56	48.5	41	58	49.5	42	58	50
May, -	42	59	55.5	40	57	48.5	44	61	52.5	46	64	55	45	64	54.5	41	60	50½
June, -	47	66	56.5	51	70	60.5	54	74	64	48	68	58	50	69	59.5	45	63	54
July, -	50	67	58.5	51	68	59.5	57	77	67	54	73	63.5	53	71	62	51	68	59½
August,	49	66	57.5	49	66	57.5	51	71	61	57	74	65.5	52	69	60.5	54	72	63
September,	47	63	55	49	65	57	50	65	57.5	49	66	57.5	45	65	55	55	67	61
October,	45	59	52	35	50	42.5	48	61	54.5	43	56	49.5	41	53	47	44	58	51
November,	32	44	38	41	53	47	44	55	49.5	34	44	39	36	46	41	43	52	47½
December,	31	42	36.5	32	41	36.5	27	40	33.5	29	38	33.5	36	42	39	39	48	43½
Ann. Mean,			47			48.04			50.12			49.21			48.29			49.21

Hence we have the Mean Temperature for six years as follows:

1816,	- -	47.0
1817,	- -	48.04
1818,	- -	50.12
1819,	- -	49.21
1820,	- -	48.29
1821,	- -	49.21
Mean of Six Years,		48.645

Mean Temperature, calculated from Dr Brewster's Formula.
$T = 81\frac{1}{2}$ cos. Lat. - - - - 50°.44

Difference between this formula and observation, 1°.80

Mean Temperature according to Mayer's formula,
Difference between this formula and observation,

The difference between the observed and calculated mean temperature will be diminished by the correction due to the height of Oxford above the level of the sea.

The following are the quantities of Rain that fell at Oxford in the above years:

	Inches.
1816,	24.328
1817,	19.260
1818,	23.077
1819,	21.156
1820,	17.757
1821,	25.110
Mean Quantity of Rain for Six Years,	21.781 Inches.

The funnel which receives the rain is on the roof of the eastern wing of the Observatory, and is about 20 feet above the ground.

Art. XXIII.—*Notice respecting Mr* Barlow's *New Discoveries on the Magnetism of Red Hot Iron, &c.*

Mr Barlow of the Royal Military Academy, in the prosecution of the magnetical experiments in which he has been for some time engaged, has discovered another curious property, which deserves to be recorded.

The first object of these experiments appears to have been to determine the relative magnetic power of different kinds of iron and steel on the needle, and his results, as connected with this determination, are as follows, viz.

	Pro. Power.		Pro. Power.
Malleable Iron,	100	Shear Steel, soft,	66
Cast-Steel, soft,	74	Ditto, hard,	53
Blistered Steel, soft,	67	Blistered Steel, hard,	53
Cast-Steel, hard,	49	Cast-Iron,	84

That is, the above numbers express the relative powers of these different metals in deflecting a magnetised needle from its natural direction. Seeing that the hardest iron and steel had the least power, Mr Barlow was next desirous of ascertaining what this comparative power might be, when heated in a furnace, and while each of the different specimens were thus rendered soft.

The results in these experiments are not so uniform as in the preceding. It is remarkable, however, that *the malleable* *iron, which has by far the greatest power when cold,* has the *least of any when heated;* and that the *cast-iron,* which is the *least powerful when cold,* is *the strongest when hot;* the increase of strength in the latter case being nearly as 3 to 1.

It was while pursuing these experiments with Mr Charles Bonnycastle, that the singular effect to which we have alluded presented itself. It was observed by both these gentlemen, that between the *white heat* of the iron (when every species of magnetic action disappears), and the blood-red heat (when the power manifests itself so strongly), there was an intermediate action, while the iron passed through the shades of bright red and red, which attracted the needle *the contrary way* to that when cold, or at the blood-red heat; that is, if the iron and compass are so posited that the north end of the needle is attracted towards the iron when cold, the *south* end will be attracted when the iron is red hot, and *vice versâ;* but as the red changes to the darkest shades of blood-red, the usual power of the iron commences, and the needle is deflected the contrary way. Moreover, this *negative attraction is least in those positions where the natural cold attraction is the greatest,* and *greatest where the latter is the least,* and *greatest of all in that position where the cold attraction is zero;* that is, in the plane of no attraction, provided (of course) the needle is sufficiently near to the bar. The bars used in these experiments were 25 inches in length, 1¼ inch square, inclined in the direction of the dipping-needle; the distance varying from 5 to 9 inches; but the nearer to the bar, the more obvious are the effects. In some of the experiments referred to above, the quantity of the negative attraction exceeded 50°.

ART. XXIV.—*Practical Rules for the Determination of the Radii of a Double Achromatic Object-glass.* In a Letter to Dr BREWSTER. By J. F. W. HERSCHEL, Esq. F.R.S.L. & E. &c.

MY DEAR SIR,

AS you suggest that a popular abstract of the results of my paper recently published in the Transactions of the Royal Society * on the Aberrations of Compound Lenses and Object glasses, may be of use to those who, without any large stock of mathematical knowledge, take a practical interest in the perfection of the telescope, I think I cannot do better than endeavour to lay them before the public, through the medium of your valuable Journal, disencumbered of all algebraical symbols, and expressed in language which no artist can misunderstand. I am well aware how formidable a barrier is raised against improvements suggested by theory, by expressing them in a manner unintelligible to the many; and that, to the artist especially, the sight of an algebraic formula is apt to excite a degree of involuntary horror, a repugnance to come in contact with it, which no assurance of its correctness or utility on the part of its author is capable of overcoming. For this reason, I have been anxious in the paper itself to separate the investigations from the results as much as possible, and to avoid the pedantry of presenting the latter in the abbreviated symbolic form adapted only to the former. At the same time, I am aware that this cannot altogether be accomplished in a work destined almost entirely for scientific perusal, and I therefore the more readily embrace the opportunity you offer me.

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* 1821, Part ii. p. 222.

The first thing essentially requisite for an artist who would construct a refracting telescope by regular rules, by any certain process, independent of trials, is to know the materials he has to work upon. The refractive and dispersive powers of the glass employed, or at least the proportion of the latter, are indispensable data, and must be obtained before any calculation from theory can be made. The former is easily obtained, by grinding a small portion of the glass into a prism or lens, and observing the deviation of the most luminous rays, or the best focus of the lens; but the latter, I am sorry to say, is an element whose determination presents great difficulties, at least when required to a degree of exactness such as the purposes of the achromatic telescope demand. In fact, the achromaticity of a double object-glass is itself so delicate a test of the adjustment of the dispersive powers of the lenses, that we cannot expect to succeed to the required degree of nicety in ascertaining their ratio in any instance, without employing a mode of observation at least as delicate. However, as this difficulty bears equally upon every construction of the telescope ever yet proposed, and as the best artists do actually, previous to working their glasses, make some estimate of the ratio of the dispersive powers, on which to ground a calculation of the radii, sufficient for their own satisfaction, I may assume, for the present, that a knowledge of the dispersive, as well as refractive powers of the media, may be obtained, remarking, only, that when an optician has the good fortune to meet with a parcel of glass from one melting-pot, sufficiently pure for his purposes, it is well worth his while to bestow the utmost pains on the accurate determination of this most important point. This will require the sacrifice of no portion of his glass capable of being used for large lenses, as neither the refractive nor dispersive powers of specimens made at one casting, can be supposed liable to such variations as materially to affect his results. A fragment cut from the corner of one of his plates will suffice, if properly used, for all his wants.

The imperfections to which refracting telescopes are chiefly liable, are well known to originate in two sources;—the want of proportionality in the dispersive actions of glasses of different kinds on the differently coloured rays, and the spherical figure of the lenses. The former of these imperfections is demonstrably insuperable in the ordinary case of a double object-glass, where only flint and crown glass are used. The best we can do is to work the lenses so as to produce the same compound focus, not for all the rays, for that is impossible, but for the two brightest and strongest colours in decided contrast with each other.

From some experiments on the colours developed by crystals in polarized light *, I am induced to conclude, that the colours we ought to take pains to unite, in order to produce the whitest possible pencil, are the brighter red, bordering on orange, and that part of the spectrum where the blue is most vivid, and begins to pass into green. Supposing these rays perfectly united, all the rest will be nearly so, and the two extremities of the spectrum will both deviate one way from the exact focus, while the intermediate portion will deviate the other, thus producing the phenomenon always observed in well adjusted achromatic telescopes when thrown out of focus, viz. a purple or lilac fringe surrounding the image of a white object, on one side of the focus, and a green on the other. This is the criterion of a good

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* *Phil. Trans.* 1820, i. p. 98.

adjustment of the foci; and to go beyond this point, with the ordinary materials, seems hopeless. I would recommend, then, to the optician who has been fortunate enough to procure fine specimens of glass, on the working of which he thinks it worth while to bestow much pains (especially if he should have enough for several object-glasses), to determine the ratio of the dispersive powers of his flint and crown glasses, by a direct experiment on small portions of his materials, working them into a small object-glass, having the ratio of the focal lengths of its component lenses, as nearly as he can guess, in the proportion of their dispersions, but leaving rather a preponderance on the side of the crown or convex lens, and then by degrees reducing the curvature of one of the surfaces of this, till he obtains the nearest possible approach to perfect achromaticity, *i. e.* till the purple and green fringes surrounding a white object on a black ground, appear in it as above described, when thrown one way or the other out of focus (using a pretty strong magnifier). Let him then determine accurately, *by experiment*, the focal length of each of his two lenses, and dividing the one by the other, he will obtain a *dispersive ratio* (ratio of the dispersive powers), on which he may calculate *with perfect security* in his future operations. If he know the exact radii of his tools, he may at the same time determine the refracting powers of the media.

These data once obtained, we are prepared to determine from theory the radii of the several surfaces which, in a telescope of given focal length, shall destroy that imperfection which arises from the spherical figure. This problem is well known to be of the kind called indeterminate, or admitting an infinite variety of solutions. In consequence, an unlimited variety of combinations of lenses, free from spherical aberration, may be discovered; and to fix our choice among them, is a matter of considerable delicacy, as well as importance. Various constructions have been proposed by different writers. Thus, D'Alembert has given one, in which he destroys the spherical aberration, not merely for rays of mean refrangibility, but for those of all colours; but this, however refined in theory, is quite useless in practice, as is also another construction investigated by the same author, in which the aberration of rays diverging from a point out of the axis is annihilated, and the field (so far as the object-glass is concerned) rendered equally perfect in every part. Such refinements must be regarded as merely visionary, correcting inconveniences which have never been felt in practice, and leaving unsatisfied other more essential conditions. A much better construction was devised by Clairaut, in which the two internal surfaces are worked to equal radii, the one convex, the other concave, so as to admit of the two glasses being cemented together, and thus avoid the loss of light, by reflection at two surfaces *. Clairaut, however, has employed in his computations indices of refraction (1.600 and 1.55) higher, especially the latter, than what are now easily met with; and when the average values, those likely to occur most frequently, are employed, the construction becomes imaginary for the more dispersive kinds of glass; and within the limits for which it is real, the radii change so rapidly, as to render it difficult to interpolate between their calculated values; so that this construction loses much of its real advantage to the artist who is no algebraist.

In the construction proposed in my paper, the destruction of the spherical aberration is insured, not only for parallel rays, but also for those which diverge from objects placed at any moderate finite distance, so as to produce a telescope equally perfect for terrestrial and astronomical purposes. This is the condition introduced to render the problem determinate; but the advantage afforded by it, would not alone be such as to induce us to adopt it, in preference to many others which might be devised, were it not that the radii resulting from it are such as to satisfy other and much more important practical conditions, which may be shortly stated as follows.

1*st*, The curvatures assigned in this construction to all the surfaces are moderate; more so, indeed, than in any other hitherto proposed on true theoretical grounds, for an aplanatic object-glass.

2*dly*, In this construction, the curvatures of the two exterior surfaces of the compound lens, of given focal length, vary within extremely narrow limits, by any variation in either the refractive or dispersive powers, at all likely to occur in practice. This remarkable circumstance affords a simple practical rule, applicable in all ordinary cases, for calculating the curvatures in any proposed state of the data, and requiring only the use of theorems with which every artist must be familiar, and, at all events, rendering it extremely easy to interpolate between calculated values. I have shewn in my paper, that *a double object-glass will be nearly free from aberration, provided the radius of the exterior surface of the crown lens be* 6.72, *and of the flint* 14.2, *the focal length of the combination being* 10.00, *and the radii of the interior surfaces being computed from these data, by the formulæ given in all elementary works on optics, so as to make the focal lengths of the two glasses in the direct ratio of their dispersive powers.*

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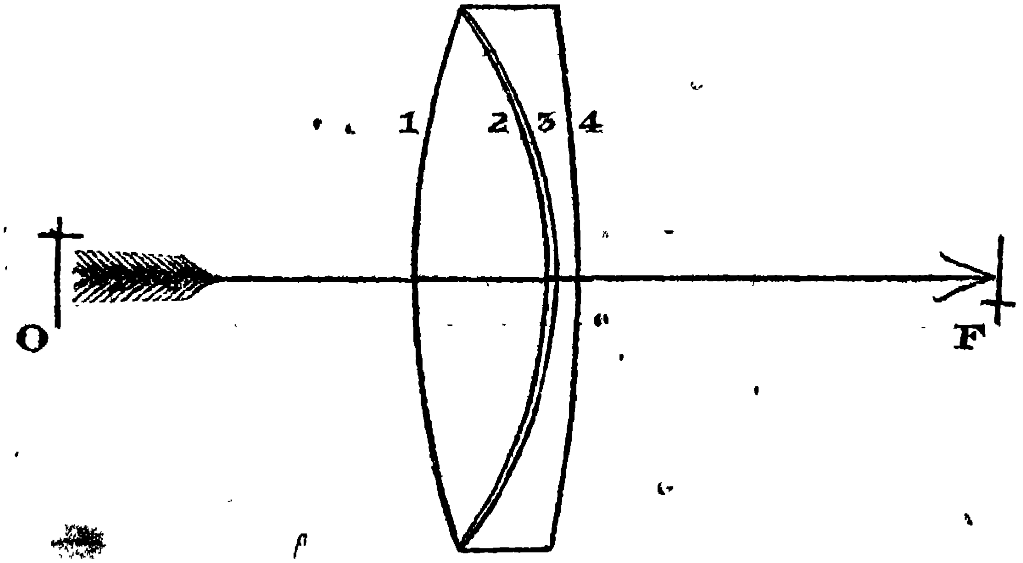
* Should Dr Wollaston's ingenious mode of centering glasses, by the reflected images, ever come into general use (of which, from its facility and neatness, there can be little doubt), this destruction of the interior reflections will, instead of an advantage, become a source of inconvenience.

In this construction, the anterior glass, or that which first receives the incident rays, is crown, and is double convex, of unequal convexities, the flatter surface being placed outwards, while the posterior lens, formed of flint-glass, is concavo-convex, having its concave surface applied against the posterior or most convex surface of the crown lens. The combination is represented in the annexed figure, where the four surfaces are numbered in the order in which the light traverses them, O being the object, and F the image formed in the focus.



The rule here stated is given only as approximative, and will no doubt be sufficiently exact for ordinary use; but when object-glasses of great size and value are to be constructed, their radii must be computed more strictly; and for this purpose I have subjoined a table, calculated upon the rigorous formulæ, the construction and employment of which will be explained presently.

3dly, Another practical advantage afforded by this construction, is, that the two interior surfaces approach in all cases so near to coincidence, that no sensible error can arise from neglecting their difference, and figuring them on tools of equal radii. Indeed, for a dispersive ratio a little above the average, they would coincide rigorously, and this construction would be identical with that of Clairaut above mentioned; and so nearly is this approach to equality sustained throughout the whole extent of the variations in the data, that even when the dispersive ratio is so low as 0.75 : 1 (a case almost useless to consider), the difference amounts to less than $\frac{1}{10}$th part of the curvature of each.

TABLE.—Dimensions of an Aplanatic Double Object-glass.

Refractive Index of Crown Lens, - 1.524 } Compound Focal Length, 10.000
Refractive Index of Flint Lens, - 1.585 }

Dispersive Ratio.	1st Surface, Convex,			2d Surface, Convex.	3d Surface, Concave.	4th Surface, Convex.			Focal Length of the Crown Lens.	Focal Length of the Flint Lens.
	Radius for the above Refractive Indices.	Variation of Radius for a change of + 0.010 in Ref. index of Crown Gl.	Variation of Radius for a change of + 0.010 in Ref. index of Flint Gl.	Radius.	Radius.	Radius for the above Refractive Indices.	Variation of Radius for a change of + 0.010 in Ref. index of Crown Gl.	Variation of Radius for a change of + 0.010 in Ref. index of Flint Gl.		
0.50	6.7485	+ 0.0500	— 0.0036	4.2827	4.1555	14.3697	+ 0.9921	— 0.3962	5.0	10.0000
0.55	6.7184	+ 0 0740	— 0.0011	3.6332	3.6006	14.5353	+ 1.0080	— 0.5033	4.5	8.1818
0.60	6.7069	+ 0 0676	+ 0.0037	3.0488	3.0640	14.2937	+ 1.1049	— 0.6659	4.0	6.6667
0.65	6.7316	+ 0.0563	+ 0.0125	2.5208	2.5566	13.5709	+ 1.1614	— 0.6323	3.5	5.3946
0.70	6.8279	+ 0.0335	+ 0.0312	2.0422	2.0831	12.3154	+ 1.1613	— 0.7570	3.0	4.2858
0.75	7.0816	— 0.0174	+ 0.0568	1.6073	1.6450	10.5186	+ 1.0847	— 0.7207	2.5	3.3333

The dimensions in the above Table are computed on the supposition of the focal length of the object-glass being 10; and to adjust them to any other assigned focal length, all that is required is to increase or diminish the radii here set down, in the proportion of the assigned focal length (in inches, feet, or parts of any given scale) to 10 parts of the same scale.

When the refractive powers of the two media are exactly 1.524 and 1.585 (which are nearly their average values) respectively, and the dispersive ratio is any one of the numbers in the first column, this table gives at once the exact values of the radii required; but when this is not the case, we must proceed as follows:

Suppose (for example's sake) we would find the proper radii for the surface of an object-glass of 30 inches focal length, the refractive index of the crown lens being 1.519, and that of the flint 1.589, the dispersive power of the former being to that of the latter as 0.567 : 1, or 0.567 being the dispersive ratio.

The computation must first be made as for an object-glass of 10 inches focus; and first we must determine the focal lengths of the separate lenses. To this end,

1. Subtract the decimal (0.567) representing the dispersive ratio from 1.000; and the remainder, multiplied by 10, is the focal length of the crown lens (in this case 10 × 0.433, or 4.330).

2. Divide unity by the decimal above mentioned (0.567), subtract 1.000 from the quotient, and multiply the remainder by 10, and we get the focal length of the flint lens. In the case before us, $\frac{1}{0.567} = 1.7635$, and $0.7635 \times 10 = 7.635$ is the focal length required.

We must next determine, by the tables, the radii of the 1st and 4th surfaces for the dispersive ratios there set down (0.55 and 0.60), next less and next greater than the given one. For this purpose we have

Refractive powers given,	-	1.519	and 1.589
Refractive powers in Table,	-	1.524	1.585
Differences,		— 0.005	+ 0.004

the given refraction of the crown being less, and the flint greater, than their average values on which the table is founded.

Looking out now opposite to 0.55 in the first column for the variations in the two radii corresponding to a change of + 0.010 in each of the two refractions, we find as follows:

		1st Surface.	4th Surface.
For a change =	+ 0.010 in the Crown,	+ 0.0740	+ 1.0080
For a change =	+ 0.010 in the Flint,	— 0.0011	— 0.5033

But, the actual variation in the crown, instead of + 0.010, being —0.005, and in the flint, instead of +0.010, being +0.004, we must take the proportional parts of these, changing the sign in the case of the crown. Thus, we find the variations of the first and last radii to be,

	1st Surface.	4th Surface.
For — 0.005 variation in the Crown, -	— 0.0370	— 0.5040
For + 0.004 variation in the Flint, -	— 0.0004	— 0.2013
Total variation from both causes,	— 0.0374	— 0.7053
But the radii given in Table are, -	+ 6.7184	+ 14.5353
Hence radii interpolated,	6.6810	13.8300

If we interpolate (by a process exactly similar) the same two radii for a dispersive ratio 0.60, we shall find respectively,

	1st Surface.	4th Surface.
For — 0.005 variation in Crown, -	— 0.0338	— 0.5524
For + 0.004 variation in Flint, -	+ 0.0015	— 0.2264
Total Variation,	— 0.0323	— 0.7788
Radii in Table, - - - -	6.7069	14.2937
Interpolated radii, - - - -	6.6746	13.5149

Having thus got the radii corresponding to the actual refractions, for the two dispersive ratios 0.55 and 0.60, it only remains to determine their values for the intermediate ratio 0.567, by proportional parts. Thus,

		1st Radius.	4th Radius.
For	0.600	6.6746	13.5149
For	0.550	6.6810	13.8300
Differences,	+ 0.050	— 0.0064	— 0.3151

We then say 0.050 : 0.567 — 0.550 = 0.017 : : — 0.0064 : — 0.0022
and 50 : 17 : : — 0.3151 : — 0.1071

So that 6.6810 — 0.0022 and 13.8300 — 0.1071; or 6.6788 and 13.7229, are the true radii corresponding to the given data.

Thus, we have in the crown lens,

Focal length, - = 4.330
Radius of one surface, = 6.6788
Index of Refraction, = 1.519

From which data it is easy to compute, by rules familiar to every optician, the radius of the other surface, which will come out 3.3868.

Again, in the Flint lens, we have,

Focal length, - = 7.635
Radius of one surface, = 13.7229
Index of Refraction, = 1.589

whence we find 3.3871 for the radius of the other surface.

The four radii are thus obtained for a focal length of 10 inches; and to obtain them for 30 inches, we have only to multiply them by 3, and we obtain finally, in the case proposed,

Radius of 1st Surface,	of 2d,	of 3d,	of 4th,
20.0364 Inch.	10.1604 Inch.	10.1613 Inch.	41.1687 Inch.

So that here the radii of the two adjacent surfaces scarcely differ more than $\frac{1}{1000}$th of an inch, and they may of course be cemented together, should it be thought desirable. I am,

Yours, &c.

J. F. W. HERSCHEL.

ART. XXV.—*Proceedings of the Royal Society of Edinburgh.* (Continued from p. 162.)

Dec. 17. 1821.—A Paper by Dr Brewster was read, containing an "*Account of a new and extraordinary structure in the Faroe Apophyllite.*"

On the same evening, a letter from Professor Moll of Utrecht, to Dr Brewster, was read, containing an account of some new electro-magnetic experiments. This letter is printed in the present number, p. 220.

1822, *Jan.* 7.—At this meeting the following Members were elected:

FOREIGN MEMBERS.

M. Ampere, Paris.
M. Van Swinden, Professor of Natural Philosophy, Amsterdam.
M. Shumacher, Professor of Astronomy, Copenhagen.

ORDINARY MEMBERS.

Francis Chantry, Esq. F. R. S. Lond., &c.
Edward Troughton, Esq. F. R. S. Lond.
James Smith, Esq. of Jordanhill.
William Bonar, Esq.
Colin Mackenzie, Esq.
Rev. H. Parr Hamilton.

A paper by Dr Brewster was read, containing an account of a "*New Species of Double Refraction.*"

A paper by Dr Dyce of Aberdeen, containing an account of a singular case of Uterine Irritation, and its effect upon the mind, was laid before the society Dr Dewar was requested to draw up a Report on this communication.

Jan. 21.—Sir George Mackenzie read a paper "*On the formation of Calcedony,*" which he illustrated by the exhibition of his fine collection of specimens from Iceland and Faroe.

Feb. 4.—Mr P. F. Tytler read a paper, entitled "Biographical Sketches of some of the earliest of our Scottish Lawyers, preceded by a view of the political condition of Scotland during the latter part of the sixteenth century."

On the same evening the following gentlemen were elected

ORDINARY MEMBERS.

Captain J. D. Boswall, R. N.
Dr John Aitken.
James Graham, Esq.
George Walker Arnott, Esq.

Feb. 18.—A paper by Mr Haycraft was read, "*On the Specific Heat of the Gases.*" From the experiments detailed in this paper, it appears, that the specific heat of all the gases enumerated, is the same when they are freed from moisture; and that when they are combined with water, they have their capacities affected in certain regularly ascending ratios, as 1, 2, 3, and 4, dependent, it would appear, on the proportions of water with which they are combined.

On the same evening Dr Dewar read his report on Dr Dyce's paper.

March 4.—The following gentlemen were elected Members:

FOREIGN.

Professor Mohs of Freyberg.

ORDINARY.

Rev. John Lee, M. D.
John Ayton, Esq. of Inchdarnie.
Richard Saumarez, Esq.

On the same evening, Dr Borthwick read a "*Notice relative to some Surgical Instruments found at Pompeii.*"

A notice by Dr Brewster was read, "*On the Structure and properties of a vegetable membrane, known by the name of Rice Paper.*"

On the same evening a notice was read, of "*Mr Barlow's discoveries respecting the Magnetism of Red Hot Iron.*"

The following Works have been recently presented to the Society :

18 Volumes of the *Memorie della Societa Italiana.* By his Royal Highness the Archduke Maximilian.

13 Volumes of the *Memoires de l'Academie des Sciences.* By the Royal Academy of Sciences of Paris.

36 Volumes of the *Transactions of the Society of Arts.* By the Society for the Encouragement of Arts and Manufactures in London.

20 Volumes of the *Memorie della Reale Accademie delle Scienze di Torino.* From the Academy of Turin.

A complete set of the *Transactions of the Literary and Philosophical Society of Utrecht.* From the Society.

The *Asiatic Researches.* From the Society.

Several Numbers of the *Flora Batava.* From the King of the Netherlands.

Delambre's *Histoire d'Astronomie Ancienne*, 2 Volumes 4to. From the Author.

Delambre's *Traité d'Astronomie*, 3 Volumes. From the Author.

Dr Hibbert's *Description of the Shetland Islands.* From the Author.

Memoirs of the American Academy of Arts and Sciences, Vol. IV. Part II. From the Society.

M. Ampere's *Memoir on Electro-Magnetism.* From the Author.

Prof. Schumacher's *Astronomische Hulfstafeln* for 1821. From the Author.

A Sanscrit MS. By James Macpherson, Esq. of Belleville.

Transactions of the Cambridge Philosophical Society, Vol. I. From the Society.

Dupin's *Voyages dans la Grande Bretagne*, 3 vols. From the Author.

Boué's *Essai Geologique.* From the Author.

Degerando's *Visiteur des Pauvres.* From the Author.

Art. XXVI.—*Proceedings of the Wernerian Natural History Society.*

1821, *Nov.* 17.—The Secretary read two communications from Captain Scoresby *junior*; one containing further remarks on the impregnation of pieces of wood by sea-water, when sunk to great depths; and the other on the cause of the fogs prevalent in the Greenland seas. (These communications have already appeared in the present volume of this Journal, pp. 115.–118.)

At the same meeting were read, 1. A letter from Mr George Anderson of Inverness, stating correctly the boundaries of a small district of Primitive Rocks, near Stromness in Orkney, the remainder of the islands being wholly of secondary formation: 2. A letter from Dr Oudney, mentioning the principal objects of his exploratory voyage to Africa; and, 3. A letter from Dr Richardson, the naturalist attached to the overland Arctic Expedition, giving an account of the geognostic features of the country which had been traversed.

Dec. 1.—Professor Jameson gave a general account of a paper on the Crystallizations of Copper-pyrites, by M. Haidinger of Freyberg. This will appear in the next part of the Society's Memoirs, which the Council has recommended, for the future, to be published half yearly, in April and November.

Dec. 15.—The Secretary read, 1. A notice regarding the Fossil Animal of Whitby, contained in a letter from the Reverend George Young to Professor Jameson: 2. Meteorological Observations made during a residence of some years on the north side of Jamaica, by Dr Arnold; and, 3. Observations on the Temperature of the Ocean at different depths; on the Indications of the Weather afforded by the barometer off the Cape of Good Hope; and on the Under Currents observable in the deep sea, generally flowing in a direction different from those of the surface, by Captain Wauchope, R. N. At the same meeting, Dr Yule read some remarks on an undescribed species of Rotang from Ceylon, of which he exhibited a specimen, 230 feet in length, brought from the forests of Candy, by P. Yule, Esq.

Dec. 29.—Mr Greville communicated descriptions, with drawings of several Fungi new to Scotland, and discovered by him chiefly in the neighbourhood of Edinburgh. The Secretary read, 1. A letter from the Reverend Mr Young of Whitby, giving an account of the Kirkdale Caverns, Yorkshire, in which numerous bones of the elephant, rhinoceros, and hyæna occur; and, 2. A letter regarding the progress of the Arctic Land Expedition, dated 16th April 1821, at the winter-hut of the expedition, on the outskirts of the most remote woods, Lat. 64.28, and W. Long. 113.06, being 133 miles directly north from Fort Providence, and 56 geographical miles south of Copper-Mine River, which had been visited by some of the party, and reported to be navigable.

1822, *Jan.* 12.—Mr Greville read the Description of a new species of Grimmia *(G. leucophæa)*, detected by him in the King's Park, at Edinburgh. The Secretary read a communication from Mr Selby of Twizell House, mentioning some rare birds which have of late years been observed in Northumberland: Likewise an account of the district of country between the rivers Jumna and Nerbuddah in Hindostan, by Dr Adam of Calcutta. And a letter from Mr Bald, civil engineer, describing the Girvan Coal-field in the south-west of Scotland.

Jan. 26.—Professor Jameson read a communication from Dr Boué of Paris, descriptive of the Rocks in the North of Germany, and on the shores of the Baltic, and ascribing to those of the granite and trap series an igneous origin. The Secretary read an account of the Diamond Mines of Punnah, by Dr Adam of Calcutta. And Mr Greville presented descriptions and drawings of two new plants of the order Algæ, found in the neighbourhood of Edinburgh.

ART. XXVII.—*Proceedings of the Cambridge Philosophical Society.*

1821, *Nov.* 12.—DR E. D. Clarke, Professor of Mineralogy, laid before the Society a communication which he had received from Dr Brewster, in which he states, that he has examined with great care a specimen of Leelite, and found it to be an irregularly crystallised body resembling hornstone, flint, &c. and having a sort of quaquaversus structure, or one in which the axes of the elementary particles are in every possible direction. The alumina which leelite contains, gives it quite a different action upon light from any of the analogous siliceous substances, and thus an optical character is obtained, by which it may be distinguished with the greatest facility.

A paper was read by J. Okes, Esq. on a peculiar case of the enlargement of the Ureters in a boy.

After detailing the symptoms of the case during life, from which no satisfactory inference could be drawn respecting the nature of the disease, Mr Okes described the appearance upon dissection. The bladder was healthy, but the orifices of the ureters unusually large, and so formed as to allow the free ingress and egress of urine through them. The calibre of these tubes was in some parts larger than the rectum, and formed convolutions not very dissimilar to those of the intestines. From all the circumstances of the case, which were traced back to the child's infancy, Mr Okes is induced to attribute the dilatation of the ureters, and destruction of the kidneys, to an original malformation of the vesical end of the ureters, and shews the improbability of its having been caused by the passage of calculi through them.

Nov. 26.—Notice of an instance of fossil bones found on the road between Streatham and Wilburton, in the Isle of Ely, by Dr F. Thackeray.

A communication, by the Reverend William Mandell, B. D. of Queen's College, on an improvement on the common mode of procuring potassium. In the common process, a considerable inconvenience arises from the lute cracking and consequent fusion of the gun-barrel, which contains the materials. Mr Mandell prevents this accident, by enclosing the barrel in a tube of well burnt Stourbridge clay, whose diameter is rather larger than that of the barrel.

A paper by William Whewell, Esq. M. A., Fellow of Trinity, "*On the Crystallisation of Fluor Spar.*"

Mr Whewell considers, in this paper, the formation of those macles of fluor which are usually brought from Aldstone Moor. Suppose two cubes of fluor, whose faces are parallel, to penetrate each other, and suppose the interior cube to revolve round its diagonal through an angle of 60°, the angle of the second or parasite cube would then appear above the faces of the original cube or not, according to its position and magnitude. Mr Whewell then gives a formula, by which (when one crystal penetrates another, and by revolving round an axis through a determinate angle, makes its angles protrude above the faces of the crystal,) the position of the axis and angle through which it revolves may be determined by the measurement of the angles which the lines of section and faces of the parasite crystal make with the edges and faces of the original crystal.

J. S. Henslow, Esq. M. A. of St John's, commenced the reading of a paper on the Geology of Anglesea.

The term Micaceous Schist would perhaps include the whole series of the oldest stratified rocks in Anglesea, which vary considerably in mineral character, but do not allow of separation into distinct formations. An exception is made in favour of a quartz-rock, which occurs in two localities in Holyhead Island. The real structure of this consists of a succession of contorted strata, rudely conformable to each other, a disposition which it is difficult to perceive, except in particular positions. There is a deceptive appearance resembling stratification, which arises from the parallelism preserved between the scales of mica dispersed through the rock, causing an imperfect kind of cleavage, inclined at a considerable angle to the horizon. This appears to arise from some effort of crystallisation posterior to the original depositions of the beds. The variety which succeeds this is a chlorite schist, which also appears, in certain situations, to consist of a certain succession of beds or strata, and to have obtained a laminated structure posterior to their deposition, differing, however, from that of quartz-rock, in being parallel to the strata, and consequently partaking of the contortions with which they are marked. Mica-slate and clay-slate are found associated with the chlorite-schist, and pass gradually into it. The chlorite-schist is associated in three or four places with heterogeneous materials, among which are jasper, dolomite, and serpentine, intermixing with the greatest confusion. It also passes to a rock between hornstone and jasper.

Dec. 3.—A communication was read, by the Reverend J. Cumming, Professor of Chemistry, "*On a remarkable Human Calculus*, in the possession of Trinity College." This calculus weighs 32 ounces; its specific gravity is 1.756, and it measures 15½ inches in circumference. Its nucleus is lithic; to this succeeds a considerable portion of the oxalate of lime variety, followed by layers of the triple crystals, covered by a thick coating of lithic, which is occasionally broken by a layer of the triple crystals, and the external surface is principally composed of the fusible calculus. Professor Cumming notices also a calculus composed of vegetable matter and the phosphates, found in the intestines of a horse, which weighs 64 ounces, and measures 37 inches in circumference.

Mr Henslow proceeded with his paper on the Geology of Anglesea. The chlorite-schist is succeeded by clay-slate and greywacke, which generally possesses a laminated structure, the plates inclined at a very considerable angle to the horizon, and probably wholly independent of any original order of deposition. In one place, the lower beds of greywacke assume the form of a conglomerate of rolled pebbles, which Mr Henslow shews to be a deceptive appearance, the nodules being in fact of a concretionary nature. Old red sandstone occurs on a fine grained red and green sandstone, but more generally as a breccia, composed of angular fragments of quartz and slate. The greater part appears to have undergone considerable alteration since its deposition, having become more crystalline and compact from the ingredients running together, and in some places forming a homogeneous quartz-rock. This is the oldest formation in Anglesea, in which traces of organised bodies were found. These consist of the casts of small Anomiæ and other bivalve shells. The mountain-lime and coal-measures are found conformable to the old red sandstone in one part alone of Anglesea. In every other instance they terminate abruptly against the schist. The grit is observed to penetrate the limestone in large cylindrical masses, in the same manner as gravel and sand penetrates the chalk. Strata of fine grit shew a tendency to assume a laminated structure oblique to the direction of the beds. A series of beds, composed of limestone and shale, succeed the last, apparently unconformable to the coal-measures. These are characterised by the prevalence of bitter-spar and a deep red tinge. Upon them is placed a rude mass of argillaceous and siliceous materials, presumed to belong to the lowest beds of the new red-sandstone.

A portion of a paper by C. Babbage, Esq., M. A., was read, "*On the Use of Signs in mathematical reasoning*"

ART. XXVIII.—SCIENTIFIC INTELLIGENCE.

I. NATURAL PHILOSOPHY.

ASTRONOMY.

1. *Comet of* 1819, *that seems to have passed over the Sun.*—We have already had occasion (Vol. II. p. 379.; Vol. III. p. 399.; and Vol. V. p. 216.) to give an account of this comet, which has been diligently observed in America as well as in Europe. Professor Fisher observed it from the 2d to the 30th July; and Mr Bowditch from the 3d to the 22d, and they deduced from their observations the following elements:

	Prof. Fisher.	Mr Bowditch.
Perihelion distance, - -	0.3366878	0.3363866
Time of passing the Perihelion, June 27.		
Mean time at Greenwich, -	11^h 56′ 23″	13^h 30′ 20″
Inclination of orbit, - -	80° 56′ 17″	80° 56′ 7″
Longitude of Ascending Node, -	273 39 18	273 54 32
Place of Perihelion, - -	286 21 33	286 27 11
Motion direct, - -		

If the correctness of these elements is admitted, the comet, when it crossed the ecliptic, must also have passed over the sun's disc. Professor Fisher has given the following elements of this transit:

Mean time of apparent beginning of the Transit, June 25.	10^h 15′ 20″
Ditto of end, - - - -	13 53 44

According to Mr Bowditch's elements, the comet must have passed the centre of the sun's disc at 7 o'clock in the morning of June 26. at Greenwich.—*Memoirs of the American Academy of Arts and Sciences*, vol ix. p. 313. 318.

OPTICS.

2. *Mr Herschel's Experiments on Plagiedral Quartz.*—In our 4th vol. p. 371. we have given a short abstract of Mr Herschel's ingenious paper on Circular Polarisation, in which he announced the very important fact, that the direction of the circular polarisation coincided with that of the plagiedral planes, in no fewer than twenty-three crystals, without a single exception. Mr Herschel informs us that he has more recently examined thirty additional crystals of quartz from Mont Blanc, all of which exhibit the same relation; so that the generality of the fact may now be considered as established beyond a doubt. Mr Herschel has likewise observed the curious fact, that the number of plagiedral crystals in which the planes have an inclination to the left, are to those which have them in the opposite direction nearly as 2 to 1.

3. *New Property of the Ordinary Ray of Crystals with two Axes.*—M. Fresnel has recently discovered, that in crystals with two axes of double refraction, the ordinary ray undergoes variations of velocity and refraction, analogous to the extraordinary ray, but confined within less extended limits.—*Bibl. Universelle*, Dec. 1821, p. 267.

4. *Singular Effect of Heat on the Colouring Matter of Ruby.*—In subjecting rubies to high degrees of heat, Dr Brewster observed a very singular effect produced during their cooling. At a high temperature, the *Red Ruby* becomes *Green*; as the cooling advances, this green tint gradually fades, and becomes *Brown*, and the redness of this brown tint gradually increases till the mineral has recovered its primitive brilliant red colour. A green ruby suffered no change from heat; and a bluish-green sapphire became much paler at a high heat, but resumed its original colour by cooling.

ELECTRICITY.

5. *Singular Effect of Lightning at Geneva.*—Professor Pictet communicated to the Helvetic Society an account of a singular effect produced by a stroke of lightning on the 3d of July last. The house had no conductors, but its roof was covered with white iron, and had bars of the same metal communicating with the ground. The stroke of lightning did no damage

to the house, but the lightning perforated a piece of white iron with *two holes*, of an inch in diameter, and five inches distant; and, what was very remarkable, the *burs at the edges of the holes were in opposite directions*. Hence, as Professor Pictet remarks, it appears to follow, either that the electric fluid has passed through the white iron, forming one hole, and, after moving five inches along it, has penetrated it again in an opposite direction; or that two currents of electric fluid had moved simultaneously in opposite directions, and at the distance of five inches from each other.

METEOROLOGY.

6. *Mr Bowditch on the Meteor of Nov.* 21. 1819.—Mr N. Bowditch has published, in the Memoirs of the American Academy of Arts and Sciences, a very full account of the large and brilliant meteor which was seen on the 21st November 1819, at such a height above the earth, that it was visible at the same time in Danvers, Massachussets, Baltimore and Maryland, by persons above 380 miles distant from each other. The size was equal to that of the moon; its first appearance was marked by a quantity of falling sparks; and two minutes after losing sight of it, a rumbling noise, like distant and protracted peals of thunder, was heard for upwards of 90 seconds. The light was equal to that of the sun when just emerging from the horizon. By comparing the various observations which were made on this meteor, Mr Bowditch assumes the following places of the meteor as those which on the whole will best satisfy the aggregate of the observations.

	At its appearance.	At its disappearance.
Latitude of the Meteor, -	40° 23′ N.	39° 11′ W.
Longitude of ditto, - -	74 34 W. of Greenw.	76 3
Height above the Earth's surface,	38 miles.	22 miles.

Its apparent direction over the earth's surface was nearly S. 44° W. The duration of its appearance was about 16 seconds, and *its velocity was about* 7½ *miles* per *second*. Its actual diameter appeared to be about 2710 feet, or nearly *half a mile.*

7. *Remarkable Aurora Borealis seen in Scotland.*—On Wednesday evening the 13th February 1822, Sir George Mackenzie,

while travelling between Forres and Nairn, observed between seven and eight o'clock a very singular aurora borealis, of which he has favoured us with the following account: "Between seven and eight o'clock in the evening of Wednesday, my eye was instantly attracted by a brilliant arch of light above the northern horizon, extending, as nearly as I could guess, about 60°, and in breadth about 3° or 4°. Above this luminous arch was another twice the breadth, but very faint. After I had admired this phenomenon for some time, a sudden burst of light broke forth at the east end of the arch, and quickly assumed the form and motions of an ordinary aurora. This change proceeded with considerable rapidity from east to west, until the whole was involved in fantastic movements and coruscations. This appearance continued for some time, and at last settled in the usual forms of an aurora borealis, the movements becoming scarcely perceptible. The masses of light gradually dispersed; and after the lapse of about three quarters of an hour from the time I first observed the luminous arch, the whole had assumed the forms of two contiguous and broad arches of faint light. How long this appearance continued, I do not know, my arrival at Nairn having put an end to my observations. I should have remarked, that the tops of the arches were always directly under the Pole star. The sky was clear; and on my arrival at Inverness it was freezing. This was about eleven o'clock."

8. *Meteoric Fire in the Marsh of the Chapelle-aux-Planches.*—In a marsh of this name in the department of the Aube, M. Doe, on the evening of the 26th May 1821, observed a quadrangular pyramid of light, of a pale red colour, approaching to white. Upon going to the marshy ground from which it arose, he found that the greatest height of the pyramid was from ten to twelve feet, and that one could read by means of its light, which was not accompanied with any heat. At the end of half an hour, its altitude diminished, and it broke down into patches of light three or four feet broad, dispersed over the surface of the marshy ground. The light did not completely disappear till about three o'clock in the morning.—*Journal de Physique*, Sept. 1821, tom. xciii. p. 236.

9. *SUMMARY of Meteorological Observations made at Alderley Rectory, Cheshire, in* 1821.

Months.	MEAN OF THERMOMETER.			THERMOMETER.		MEAN OF BAROMETER.			BAROMETER.		Prevailing Winds, and No. of days of each.				Variable.	Snow or Rain.	Fall of Rain.
	A. M. 8	P. M. 2	P. M. 10	Max.	Min.	A. M. 8	P. M. 2	P. M. 10	Max.	Min.	N.	E.	S.	W.			
January,	35.25	40.45	36.80	54	12	29.42	29.43	29.45	30.35	28.10	2	10	17	2		8	1.19
February,	34.17	39.08	33.20	51	15	.83	.83	.82	30.25	28.85	6	8	11	3		6	.57
March,	37.19	46.32	39.87	57	21	.18	.18	.18	29.90	28.60	3	2	16	10		22	3.40
April,	45.70	54.76	43.83	67	26	.20	.19	.24	29.65	28.70	7	3	14	5	1	18	2.98
May,	44.77	52.06	42.16	66	26	.43	.43	.44	29.80	28.70	6	5	6	14		17	3.18
June,	51.63	58.40	46.61	71	33	.67	.66	.65	29.95	29.25	21	5	1	3		10	1.38
July,	54.22	59.19	50.12	67	35	.45	.45	.47	29.85	29.00	9	1	14	6	1	16	2.05
August,	55.32	62.22	52.48	74	42	.46	.45	.46	29.75	28.95	2	6	17	6		18	4.46
Septemb.	52.93	59.90	50.30	69	37	.37	.37	.37	29.75	28.85		2	16	12		24	6.06
October,	44.16	50.67	42.16	65	31	.42	.42	.43	29.95	28.50	3	2	18	8		17	2.76
Novemb.	42.16	46.96	41.86	58	23	.29	.38	.29	29.85	28.55	2	1	17	10		23	5.49
Decemb.	38.61	42.54	39.03	55	27	28.97	28.97	28.96	29.80	27.85	2		20	7	2	19	5.52
Average,	44.67	51.07	34.20	62.83	27.33	29.39	29.39	29.39			63	45	167	86	4	198	39.04

MEAN TEMPERATURE of the Year by Three Observations, - 46°.3

MEAN of Maximum and Minimum, - - - - - - 46°.08

10. *Extraordinary Storm of Rain at Catskill in N. America.* —On the 26th July 1819, a very remarkable and unusual storm of rain took place at Catskill, on the west side of the Hudson River, and about 120 miles north from the city of New York. In consequence of the meeting of two black clouds, accompanied with thunder and lightning, a dreadful rain fell, sometimes in large drops, sometimes in streams, and at other times in sheets.

The quantity of rain that fell was estimated, from very good data, at *fifteen inches*,—a quantity nearly equal to what falls in many places during a whole year. In some places within the limits of the storm, *eighteen inches* is supposed to have fallen; and Mr Dwight calculates, that, in the month of July, the quantity of rain that fell amounted to *twenty-four inches*. The devastations committed by this storm were tremendous; but as they are only of local interest, we must refer the reader for an account of them to the *American Journal of Science*, vol. iv. p. 124,—142.

11. *Salt Storm in North America of the 3d September* 1821.—The dreadful gale which blew at Newhaven from the S.E. gradually increased from noon till dark, when it raged with tremendous violence, and continued till near midnight. "It terminated very abruptly, and passed in a very short time from a hurricane to a serene and star-light night Near midnight, a loud report was heard by many, and it was observed that the wind ceased immediately after." Next morning, the windows were found covered with salt; the trees exhibited a blasted foliage; in a few hours, the leaves began to shrink and dry on the windward side, and after some days the dry leaves fell, as they ordinarily do in the latter end of November. In October, the leaves re-appeared on the windward side of the trees, new blossoms were put forth, and the water-melon and the cucumber produced new fruit. In some instances, the mature fruit was found on the same tree with the new blossoms. On the morning after the tempest, the leaves were perceptibly saline to the taste at Hebron, 30 miles from the sea; and it is stated, that the same effect was observed at Northampton, more than 60 miles inland.—See *American Journal of Science*, vol. iv. p. 172.

12. *Remarkable Fall of the Barometer on December* 25. 1821, *at Geneva, and in Scotland.*—In the *Bibliotheque Universelle* for December 1821, Professor Pictet has given a very interesting account of a most unusual fall of the barometer, which took place at half-past one o'clock of the morning of the 25th December 1821. The mean height of the barometer at Geneva is 26 inches 11 lines French measure; but on the morning of the 25th, it fell so low as 25 inches 8 lines, which is lower than it was

ever known to have fallen before. In the year 1763, it had fallen to 25 inches $10\frac{3}{4}$ lines; and M. J. A. Deluc remarked at the time, that this was lower than it had been known in the memory of man. On November 22. 1768, it sunk to 25 inches $10\frac{1}{4}$ lines; and on January 18. 1784, it likewise fell to 25 inches $10\frac{1}{8}$ lines. The remarkable depression of the barometer which took place on December 25. 1821, was accompanied with a violent storm of thunder, lightning, wind, rain and hail, and seems to have been universal over Europe. The following observations made in Scotland, will shew that the depression was simultaneous throughout all Scotland, and took place on the same day:

	Height of the Barometer. Inch. 10th.	Days on which the Barometer was lowest in 1821.
Huntly Lodge, Aberdeenshire,	27.8	Dec. 25.
Islay House, Argyleshire,	28.5	Dec. 25, 26.
Kinfauns Castle, Perthshire,	28.12	Dec. 25.
Castlesemple, Renfrewshire,	27.3	Dec. 14, 15, 25.
Inchbonny, near Jedburgh, Roxb.	27.9	Dec. 25.
Mount Annan, Dumfriesshire,	28.0	Dec. 25.
Inverness, Inverness-shire,	28.3	Dec. 25.
Clachnacary, near Inverness,	28.0	Dec. 25.
Stowe, Mid Lothian, -	28.19	Dec. 25.
Alderley Rectory, (Cheshire),	27.85	Dec. 25. and 28.
Canonmills, near Edinburgh,	28.30 Sympies.	Dec. 25.
Edinburgh, - -	28.1	Dec. 25.

13. *Fall of a Meteoric Stone at Juvinas in France.*—On the 15th of June 1821, about 4 P. M. a meteoric stone, weighing 220 lb. fell at Juvinas, N.W. of Viviers, in the department of the Ardeche. It sunk five feet into the ground. Its surface was covered with a sort of glaze. Before it fell, it appeared like an enormous mass of fire. Its fall was accompanied with a continued rolling noise, and four distinct detonations. The sky was clear, and the sun shining bright.—See the *Journal de Physique*, tom. xcii. p. 463.

14. *Meteoric Stone in Courland.*—Between five and six o'clock of the evening of the 12th July 1820, a fire-ball, about the size of the full moon, and burning with a reddish flame and tint, was seen moving slowly from S. to N. After describing an arch of 100°, it became extinguished, and its extinction was followed with a noise like three rapid discharges of great guns,

or fire of musquetry, and a continued rolling. At that moment, a stone fell about 3½ German miles from the country palace of Lixna, in the circle of Dunaberg. The stone penetrated 1½ feet into a clayey loam. It weighed 40 lbs., had the smell of gunpowder, and was hot to the touch. At the same time, a large body fell about four wersts distant into the Lake Kolupschen with a hissing noise, and dashing the spray high into the air. Three wersts in the opposite direction, something fell into the river Dubna, which made its water turbid for about an hour. The analysis of this stone is given in p. 389.

II. CHEMISTRY.

15. *On the Combination of the Earths with Platinum, &c.*—
By John Murray, Esq. Lecturer on Chemistry.

In the *Annales de Chimie*, are given the result of some experiments by M. Boussingalt, from which it appears, that *Silica* may be made to combine with Platinum and Iron. With the latter metal I made no experiments, but several with platinum, which prove, that not only silica may be made to combine with it in the formation of its alloys, but that the earthy combination is not exclusively confined to silica, as I have in like manner united *Alumina*, *Zirconia*, *Glaucina*, *Baryta*, *&c* By this statement, it must be evident that the class which comprises the alloys of platinum is capable of great extension; nor have we any authority to limit the combination of earths to platinum, or even to steel. The conclusions of Cloult and of Boussingalt receive also confirmation from the following remarks.

It may be remarked, that what M. Boussingalt referred to *carbon*, from its taking fire, &c. *might have been* silica; for, if a portion of pure silica be put on paper, and the paper set on fire, the silica will be also ignited, and it finally becomes *brown*, giving off delicate streams of minute sparks, and the silica thus recoiling on the paper, by the advance of the flame is thrown into beautiful undulations or waves. Both the protoxide and deutoxide of Barium, under similar circumstances, inflame like nitrate or oxymuriate of potassa. I have already stated, that if antimony, bismuth, zinc, tin, &c. be wrapped up in platinum-foil, and held in the flame of a spirit-lamp, a brilliant ignition ensues, and the fusion of the alloy is complete. I use a metallic plate on the neck of the spirit-lamp (if of glass), to save it from the fracture which would ensue from contact of the fused globule. In using *zinc*, some caution is necessary; the ignition is exceedingly fierce, accompanied sometimes by a *projectile lateral force* imparted to the new alloy. In one instance, it struck me on the breast with considerable power, and perforated my coat, which happened to shield me. In combining the earths with platinum and other metals, I employed the process adverted to, and succeeded. I shall confine myself at present to those of platinum and antimony. It is by no means a question with me, that the difference observable in steel is attributable to the species and quantity of earthy matter that enter into the combination; and a series of experiments on the fusion of iron, and the various earths, particularly lime and silica, might lead to conclusions of great practical value. Perhaps, also, our other alloys might in like manner be improved. As all may not have at every moment the command of a wind-furnace, when the mind suggests an experiment for trial, the simple method recommended may enable the experimentalist to examine, with little trouble, an extensive list of the alloys of platinum at any rate.

It seems to be an interesting inquiry, whether the earths combine in the form of *oxides*, or unite by their metallic bases. From the earths in my experiments being shut up and closely surrounded by the platinum-foil (allowing no exit for expelled oxygen), it should seem that the former is the case; while, on the other hand, it may be considered absorbed in the ignition which ensues.

Platinum, *Antimony*, *Charcoal* (fine levigated, from the betel-nut) and *Silica*, gave a button impressed with difficulty by the knife, and granular. Crushed in a steel-mortar, it was reduced to powder, the particles of which were very brilliant.

Platinum, *Silica* and *Antimony*, nearly similar. Parts capable of imperfect extension by the hammer; and sometimes on the edge so hard (perhaps from an imperfect combination of the silica) as to scratch glass: less bright than the preceding alloy.

Platinum, Antimony and Zirconia. The ignition here was extremely beautiful, and the fusion of the whole was more complete than any tried. It was crushed by the steel-mortar, and presented brilliant facets. The fused globules were exteriorly spotted with very minute and sparkling crystalline points. This alloy was less silvery and brilliant than that with silica and charcoal.

Glucina, Platinum and Antimony,—had a colour not unlike a specimen of native nickel from Hesse in my possession, or intermediate between pure nickel and refined silver. Scarcely abraded by the knife. Crushed in the steel-mortar, it was less granular and angular in its particles than the preceding.

Alumina, Antimony and Platinum, very much resembled the former, but was a shade darker in colour.

The alloy with silica, charcoal, *potassium*, antimony and platinum; and that with zirconia, *potassium*, &c. seemed to differ little from those *without* potassium. The potassium burns before the fusion of the alloy takes place, and perforating the platinum-foil, escapes in the character of flame, so that it would only preserve the reduction of the earthy oxide.

The combination of *Zinc, Platinum*, and *Protoxide of Barium* was ragged, scoriaceous, and very hard.

16. *Apparent conversion of Cast-Iron into Plumbago.*—In the last number of the American Journal of Science, Professor Silliman has given an account of a six-pound shot found at Newhaven Harbour, and supposed to have been there ever since 1779, which was encrusted with a shapeless, rusty brownish substance, unctuous, sectile, and leaving a mark on paper like plumbago. Various facts of the same kind have been observed in this country; and very recently Mr Hatchett obtained from Mr Whidbey at Plymouth a portion of a cast-iron gun which had been long immersed in sea-water. Mr Brande found it to consist of Oxide of Iron 81, and Plumbago 16; and he attributes the rapid decay and change in the cast-iron "to a galvanic action, the plumbaginous crust in contact with the cast-metal producing an electro-motive combination, aided by and promoting the decomposition of the sea-water, and of its saline contents."—See *Quarterly Journal*, vol. xii. p. 407. The late Mr James Watt long ago remarked this change in cast-iron, in the pumps of his steam-engines that had been exposed to the action of salt-water.

17. *On the difference between Sea and Land Air.*—Having learned that on the Baltic asthmatic invalids were much better at sea than on shore, M. Vogel analysed the air a league from the shore, and concluded, 1. That the air above the Baltic, a league from the shore, contains less carbonic acid than the ordinary atmosphere, and carbonic acid probably diminishing as we recede from the land, and, 2. That the same air contains muriates in greater or lesser quantities.—*Journ. de Pharm.* Oct. 1821.

18. *Berzelius's Analysis of Crystallised Calamine of Limbourg.*—This mineral, the electric oxide of zinc, was found to contain

	Experiment.	Theory.
Silica, - -	24.9	26.23
Oxide of Zinc, -	66.84	66.37
Water, - -	7.46	7.40
Carbonic Acid, -	0.45	———
Oxide of Lead, -	0.28	100.00
	99.93	

19 *Count D'Ohsson's Analysis of Chondrodite.*—This new mineral is found near Pargas in Finland, interspersed in granular limestone. It occurs in grains the size of a pin-head, and is of a wine-yellow colour. Spec. gravity, 3.18. Its ingredients are,

Silica, - -	38.0
Magnesia, - -	54.0
Oxide of Iron, -	5.1
Alumina - -	1.5
Potash, - -	0.86
Manganese, -	a trace.
	99.46

20. *Mr Irving's Analysis of the Foliated Sulphato-Carbonate of Lead* *.—100 Grains of the foliated Sulphato-carbonate of Lead were treated with dilute nitric acid; a brisk effervescence took place, attended by the deposition of a white powder, which appears to be sulphate of lead. This powder, on being separated by the filter, weighed - - - 29 grains.
The lead in the nitric solution was precipitated by
sulphuric acid, and when filtered, weighed 73
102

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* See our last Number, p. 183.

If the soluble part of the ore was in the state of carbonate, it ought to have gained 5 or 5½ grains by being converted into sulphate, in which case there will be a loss of 3 *per cent.*

21. *M. John's Analysis of Meteoric Iron and Meteoric Stones* —The following are M. John's analyses of Meteoric Iron *:

	Iron of Pallas.	Iron of Elbogen.	Iron of Humboldt.
Iron, -	90.0	87.5	91.5
Nickel, -	7.5	8.75	6.5
Cobalt, -	2.5	1.85	2.0
Chromium,	trace.	0.0	trace.
Manganese, -	0.0	1.9	0.0
	100.0	100.0	100.0

The following are M. John's analyses of the Iron obtained by the magnet from Meteoric Stones pulverised:

	Iron from Meteorolite of Chattonay.		Of L'Aigle.	Of Sienna.
Iron, -	92.72		92.72	92.72
Nickel, -	5.5		5.5	5.1
Sulphur, -	1.0			
Cobalt, -	0.78	Quantities too small to be weighed.		
Chrome, -	trace.			
	100.00			

22. *M. Grotthus's Analysis of the Meteoric Stone of Courland.*—This meteoric stone, the fall of which is described in p 384. consisted of the following ingredients:

Iron, -	26.0
Nickel, - -	2.0
Sulphur, - -	3.5
Silica, - -	33.2
Protoxide of Iron, -	22.0
Magnesia, - -	10.8
Alumina, - -	1.3
Chromium, - -	6.7
Lime, - - -	0.5
Manganese, -	a trace.
	100.0

23. *New Blowpipe.*—Professor Green has published an account of a new Blowpipe in the *American Journal of Science,*

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* See this *Journal,* Vol. I. p. 232, 233.

vol. iv. p. 164. The principle, however, is not new; and an instrument almost exactly similar to it was published by its inventor, John Farey, Esq. *junior*, in the article *Blowpipe*, in the *Edinburgh Encyclopædia*, vol. iii. p. 615.

HYDROSTATICS.

24. *Specific Gravities of different Bodies.*—The following Specific Gravities have been taken by MM. Roger and Dumas with great accuracy:

	Spec. Grav.		Spec. Grav.
Ice, - -	0.950	Caustic Lime, -	3.08
Silica, - -	2.650	Carbonate of Lime, -	2,717
Boracic Acid, - -	1.830	Anhydrous Sulphate of Lime,	2.960
Arsenious Acid, - -	3.698	Crystallised Sulphate of Lime,	2.322
Protoxide of Copper, -	5.749	Alumina, - -	4.200
Oxide of Bismuth, -	8.449	Nepheline, Silicate of Alumina, - -	3.270
Oxide of Lead, - -	8.010		
Peroxide of Mercury, -	11,29	Sulphur, - -	2.086

III. NATURAL HISTORY.

MINERALOGY.

25. *Cave of Kirkdale in Yorkshire.*—Some time ago a short account of the discovery of fossil remains of the hyæna and other animals in a cave or fissure at Kirkdale in Yorkshire, was read before the Wernerian Society. This interesting spot has been examined with great care by Professor Buckland, who has communicated the results of his inquiries to the Royal Society of London. The fissure or cave, as it is termed, extends 300 feet into a solid oolite rock, and varies from 2 feet to 5 feet in height and breadth. Its bottom is covered with a layer, about a foot thick, of mud, which is partially encrusted with calc-sinter. It is in this mud that the fossil animal remains are found imbedded. The bones are in a nearly fresh state, still retaining their animal gelatin. They are mostly broken and gnawed in pieces, and are intermixed with teeth. Portions of the dung of the former inhabitants of this fissure were met with, and which, on examination, was found to have the chemical properties of the fæces of the canine tribe, and in its external aspect agreed with that of the hyæna. The fossil remains found by Professor Buckland were of the following animals, viz. hyæna,

elephant, rhinoceros, hippopotamus, deer, ox, and water-rat; the four first belong to species now extinct, but of the others nothing is said. It is evident that animals having the magnitude of the elephant or rhinoceros, could not enter a fissure so low and narrow as that at Kirkdale; and it appears probable, that these bones could not have been floated into the fissure by means of water, otherwise they would not only have suffered from attrition, but would be intermixed with sand or gravel. They must, therefore, have been transported thither in some other way Professor Buckland conjectures, that they were carried in for food by the hyænas, who appear to have been the sole inhabitants of the den. The smaller animals may have been carried in entire, the larger ones piecemeal; for by no other means, Professor Buckland remarks, could the bones of such large animals as the elephant and rhinoceros have reached the furthest recesses of so small an opening, unless rolled thither by water; in which case, the angles and edges would have been worn off by attrition, which is not the case.

26. *Spinel, &c.*—Spinel, chrysoberyl, and garnet, have been lately referred to the rhomboidal system.

27. *Andalusite, &c.*—Andalusite and chiastolite, and probably also pinite, belong to the Corundum group.

28. *Berzelius on the Blowpipe.*—We have lately received a copy of Berzelius's work on the blowpipe, which is by far the most valuable treatise of the description hitherto published. Independent of the valuable details in regard to the blowpipe itself and its uses, it abounds in curious information in regard to many minerals. We intend to get it translated for the use of chemical mineralogists.

29. *Sapphirine.*—The Sapphirine of Giesecké, discovered by him in Greenland, and whose hardness and specific gravity refer it to the corundum group, contains, according to Stromeyer, the following constituent parts: Alumina 63.1; silica 14.5; magnesia 16.8; lime 0.3; oxide of iron 3.9; oxide of manganese 0.5; loss 0.4 = 99.7.

30. *Native Hydrate of Magnesia.*—Stromeyer, in his lately published very valuable volume of chemical analysis of minerals.

gives the following as the constituent parts of native hydrate of magnesia: Magnesia = 68.345; oxide of manganese 0.637; oxide of iron 0.116; water 30.902 = 100.

31. ***Eudialite.***—Amongst the many curious minerals discovered by Giesecké in West Greenland, one of the most interesting is that described under the name Eudialite, and which appears to belong to the garnet group. It contains a considerable portion of zircon earth,—a substance which has hitherto been found only in the gem named Zircon; and, what is remarkable in a mineral of this description, a large portion of alkali. The following is the analysis of Stromeyer: Silica 53.325; zircon-earth 11.102; lime 9.785.; natron 13.822; oxide of iron 6.754; oxide of manganese 2.062; muriatic acid 1.034; water 1.801. = 99.685.

32. *Sodalite.*—The sodalite of Greenland appears to belong to the scapolite tribe.

33. *Meionite.*—Arfwedson, a pupil of Berzelius, published lately an analysis of meionite, according to which it appears to contain 21.40 parts of potash; but Stromeyer has rendered it probable that the Swedish chemist had analysed a variety of leucite in place of meionite; and he himself gives the following as the result of his analysis of meionite, which agrees nearly with that of Gmelin: Silica 40.531; alumina 32.726; lime 24.245; potash, with natron, 1.812; oxide of iron 0.182 = 99.496.

34. *Lievrite.*—Although we already possess two analyses of the lievrite, one by Vauquelin, and the other by Descostils, yet as these differ from that lately published by Stromeyer, we shall here state the result of his analysis: Silica 29.278; lime 13.779; alumina 0.614; black oxide of iron 52.542; oxide of manganese 1.587; water 1.268 = 99.068.

35. *Fahlunite, &c.*—The hard Fahlunite of Fahlun in Sweden, the Steinheilite of Finland, and the Dichroite of Bavaria and Greenland, appear to be varieties of the same mineral. All of them have been analysed by Stromeyer. In his lately published memoir, he gives the following as the constituent parts of the Dichroite of Greenland: Silica = 49.170; alumina 33.106; magnesia 11.454; oxide of iron 4.338; oxide of manganese 0.037; water and loss 1.204 = 99.309.

36. *Apophyllite.*—The apophyllite of Greenland, according to Stromeyer, contains, silica 51.8564; lime 25.2235; potash 5.3067; water 16.9054 = 99.2920.

37. *Heavy-Spar.*—Stromeyer has published an analysis of the heavy-spar of Nutfield in Surrey, from which it appears, that it contains no sulphate of strontian; and further, that the proportions of the earth and the acid are nearly the same as in the artificial sulphate of barytes. This latter fact, Stromeyer remarks, is of importance, from its shewing that natural combinations of bodies are constituted according to the same fixed proportions as those which are formed artificially.

38. *Strontianite.*—The strontianite of Braunsdorf in Saxony, which was for some time arranged as a variety of arragonite, always contains a small portion of carbonate of lime, generally about 2.2 in the hundred parts. In the analysis of the strontianite of Strontian, as given by Dr Hope and Klaproth, no mention is made of carbonate of lime. The late experiments of Stromeyer, however, prove that it contains a considerable portion of that salt His analysis is as follows:

Carbonate of Strontian, - -	93.5109
Carbonate of Lime, - -	6.1658
Carbonate of Manganese, - -	0.0982
Black Oxide of Iron, - -	a trace.
Water, - -	0.0755
	99.8502

It is probable, however, that varieties of the mineral of Strontian may occur without carbonate of lime, as it is improbable that so large a portion of this salt could have escaped the notice of chemists so distinguished for accuracy and skill as Hope and Klaproth.

39. *Polyhalite.*—This remarkable mineral occurs in beds of rock-salt at Ischel in Upper Austria. It was first considered as a variety of anhydrite; but a more accurate examination of its external characters have proved, that it is not only very different from that mineral, but from all others hitherto described; and its remarkable chemical composition, as ascertained by Stromeyer, is an additional proof of the accuracy of this opinion. The following is the result of Stromeyer's analyses:

Sulphate of Potash, - - -	27.6347
Hydrous Sulphate of Lime, - -	28.4580
Anhydrous Sulphate of Lime, -	22.2184
Anhydrous Sulphate of Magnesia, -	20.0347
Anhydrous Sulphate of Iron, -	0.2927
Muriate of Soda, - - -	0.1910
Muriate of Magnesia, - -	0.0100
Oxide of Iron, - - -	0.1920
	99.0315

From the above analyses, it appears that the constituent parts are united together exactly in the proportion of their equivalents, thus proving that this mineral is not an accidental intermixture of salts. The polyhalite is farther remarkable, on account of the sulphate of potash it contains, and in this respect it is eminently distinguished from all analogous mineral species, for, with exception of natural alum, this salt has not been found as a regular constituent part of any other natural salt. And, further, as the polyhalite occurs in a bed of rock-salt, this constituent part, the sulphate of potash, is rendered the more remarkable.

40. *Picropharmacolite* contains, according to Stromeyer, lime, 24.646; magnesia, 3.218; oxide of cobalt, 0.998; arsenic acid, 46.971; water, 23.977 = 99.810.

41. *Recent Iron-Pyrites.*—Professor Meinecke observed on the Tolauer Heath, near Halle, tables of an inch in breadth of iron-pyrites, intermixed with reeds, and which he observed continued to increase in size, thus proving their new formation.

42. *Fossil Skeleton of the Mammoth and Elephant.*—An immense skeleton of a mammoth, and another of an elephant, have been dug up, in the district of Honter in Hungary.

43. *Satin-Spar* has been observed by Mr Morse at Glen's Falls; it is in thin, delicate, but extensive veins, principally in the fallen rocks below the bridge; generally it is of a brilliant white, but sometimes it is black, although still retaining its fibrous structure. *Crystals of Bitterspath*, well defined and glistening in the black limestone, occur at Glen's Falls.—*Silliman's American Journal.*

44. *Native Yellow Oxide of Tungsten*—Occurs incrusting

the ferruginous tungsten of Mr Lane's Mine, and occupying the cavities. It is not abundant. It is insoluble in acids, but readily dissolves in ammonia, from which it is precipitated by acids, white, becoming yellow.—*Id.*

45. *Tantalite in Haddam Rocks.*—Dr Torrey writes, that a specimen of the granite of Haddam, Connecticut, which he sent to Count Wachtmeister of Stockholm, has recently been examined by Professor Berzelius, and found to contain *tantalite* in a state resembling that of Finbo in Sweden. The Haddam mineral occurs crystallised in small prisms, in the same rock with the chrysoberyl.—*Id.*

46. *The Chrysoberyl of Haddam.*—The genuineness of this mineral has been admitted by Haüy, Jameson, and other distinguished mineralogists, to whom specimens have been sent; but Dr Torrey writes: "The mineral found in the granite of Haddam, which is generally supposed to be chrysoberyl, and which I sent to Professor Germar of Halle, for examination, he thinks is a new variety of beryl. The specific gravity is only 2.7. Before the blowpipe it melts into a milk-white enamel, and besides it is entirely too soft for chrysoberyl." In reply to Dr Torrey, we remarked, that we imagined the mineral examined by Professor Germar could not be the crystallised chrysoberyl of Haddam, whose character we suppose to be unquestionable. We suggested that it might be a compact Granular mineral, occurring in the same rock, and which we suppose may be Beryl in mass. Dr Torrey again writes, that he believes the mineral which he sent to Professor Germar was not crystallised: that the latter remarked, it should perhaps be called Granular Beryl, and that it is doubtless the massive mineral to which we alluded. The chrysoberyl has been recently found at Saratoga. We may mention also, that there is a locality of it in Haddam, east of the river, and different from the one usually visited. We had specimens from Dr Dart, two or three years ago, but cannot name the precise spot.—*Id.*

ZOOLOGY.

47. *Bowdich's Zoological Works.*—Mr Bowdich, the well-known African traveller, has just published three useful zoological works, intended for the use of travellers and zoologists.

The first, entitled "an Analysis of the Natural Classification of the Mammalia," contains a translation of the generic characters of the Mammalia of Cuvier, with additions regarding the comparative anatomy of these animals. The second part contains a general outline of the zoological system of the celebrated Illiger, with numerous observations by Kuhl, the naturalist at present employed in investigating the ornithology of the Indian Islands. It is accompanied with fifteen lithographic drawings, illustrative of the mammalia, the greater number of which are original. The second work, entitled, "An Introduction to the Ornithology of Cuvier, for the use of students and travellers," is executed in the same manner, and is illustrated with an interesting series of lithographic drawings, explanatory of the internal structure of birds, and of the various parts used, as characters in their discrimination and arrangement. The third work, entitled, "Elements of Conchology, including the fossil genera and the animals, Part 1. Univalve, with upwards of 500 figures," is also deserving of commendation, and will be found useful not only to the zoologist, but also to the geologist. The figures in this part are superior in beauty to those of the two first parts, and reflect much honour on the skill and taste of Mrs Bowdich, whose name, we observe, is attached to them. We have no hesitation in recommending these three small works to the notice of the young geologist, and to the attention of travellers. The geologist, too, will find the third part useful in his investigation of the testaceous remains in the mineral kingdom. We trust Mr Bowdich will continue his labours, and execute the other branches in the same style with those already before the public.

48. *Ornithorhyncus.*—"I had an opportunity of proving two curious, and, I believe, disputed facts in the history of that curious animal, the Ornithorhyncus Paradoxus, namely, a tube in the spur, connected with a cyst, through which a poison is ejected into the wound the animal inflicts, and which causes violent inflammation and swelling, but the consequences are not fatal; 2. That the animal is oviparous. I was fortunate in getting an impregnated female, in which, on dissection, I found an ovum in the ovary about the size of a pea. The natives are well aware of the circumstance that the animal lays

two eggs in its nest*. The one I dissected we found in the nest. The preparation I gave to Mr Scott, Secretary to the Honourable Commissioners, so that you may probably hear of it through another channel."—*Extract of a Letter from Dr Hill of Liverpool, New South Wales, to Sir G. S. Mackenzie.*"

BOTANY.

49. *Extraordinary Productiveness of the Orange-trees of St Michael's.*—The oranges of St Michael are celebrated for their fine flavour, and abundant sweet juice; when left to ripen on the trees, they are inferior to none in the world. The lemons have less juice than those of some other countries, and the demand for them is inconsiderable. The orange and lemon trees blossom in the months of February and March. At this time, the glossy green of the old leaves, the light, fresh tints of those just shooting forth, the brilliant yellow of the ripe fruit, and the delicate white and purple of the flower, are finely contrasted with each other, presenting one of the most beautiful sights imaginable. The trees generally attain the height of fifteen or twenty feet. The usual produce of a good tree, in common years, is from 6000 to 8000 oranges or lemons. Some instances of uncommon productiveness have occurred; a few years since, 26,000 oranges were obtained from one tree, and 29,000 have been gathered from another. These quantities have never been exceeded.—*Dr Webster.*

50. *Dr Jack's Descriptions of Trees of Sumatra and Malacca.*—Dr William Jack *junior*, son of Principal Jack of Aberdeen, an active and intelligent naturalist, has lately transmitted to this country a series of interesting descriptions of Malayan plants, a copy of which was sent to us, and from which we shall now make a few extracts.

51. *Leucophogon Malayanum.*—Dr Jack describes a new species, under the title *Leucophogon Malayanum*, as occurring at Singapore. The discovery of this species, he observes, is remarkable, as forming an exception to the general geographical distribution of the Epacrideæ, a family almost exclusively confined to Australasia, or at least to the southern hemisphere.

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* Eggs of the Ornithorhyncus were some time ago sent to the Linnean Society of London, and specimens of them are preserved in their Museum.—Ed.

Singapore, situated at the extremity of the Malay peninsula, and forming, as it were, the connecting link between continental or Western India and the islands of the great Eastern Archipelago, partakes of this character in its Flora, which exhibits many remarkable points of coincidence with the Floras of both regions. Dr Jack had occasion to observe resemblances between its productions and those of the northern frontier of Bengal, on the one hand, and of the Moluccas on the other; while the present connects it with the still more distant range of New Holland.

52. *Oriental Sassafras.*—In describing a new species of Laurus, the *Parthenoxylon*, a native of the woods of Sumatra, Dr Jack informs us, that its fruit has a strong balsamic smell, and yields an oil, which is considered as useful in rheumatic affections, and has the same balsamic odour, as the fruit itself. An infusion of the root is drank in the same manner as sassafras, which it appears to resemble in its qualities. The wood is strong and durable, when not exposed to wet. Dr Jack inquires, " May this not be the oriental Sassafras wood mentioned under the article Laurus in Rees's Cyclopædia?"

53. *Rafflesia Titan.*—Of this new genus, established by Dr Jack, and named in honour of our distinguished countryman Sir Thomas Stamford Raffles, a full account is given in the descriptions already mentioned. The only species hitherto met with, is that described under the name *Titan*, from the gigantic size of its flowers. Dr Jack informs us, that it is a native of the forests in the interior of Sumatra, where it was first discovered by Sir T. S. Raffles, during a journey into that country in 1818. This gigantic flower is parasitic on the lower stems and roots of the *Cissus angustifolia*, Roxb. The bud, before expansion, is nearly a foot in diameter, and of a deep dusky red. The flower, when fully expanded, is in point of size the wonder of the vegetable kingdom; the breadth across from the tip of one petal to the tip of the other, is little short of three feet. The cup may be estimated capable of containing twelve pints; and the weight of the whole is from twelve to fifteen pounds. The inside of the cup is of a deep purple, but towards the mouth it is marked with numerous spots of white. The petals are of a brick red

colour. The whole substance of the flower is not less than half an inch thick, and of a firm fleshy consistence. It soon after expansion begins to give out a smell of decaying animal matter. Sir T. S. Raffles sent specimens of the plant to England in 1818. In the following year, numerous additional specimens were procured from various parts of the country, and an opportunity offered of more minute examination, the particulars of which are given in Dr Jack's description, already referred to. The greater part of these specimens were transmitted to England, together with the observations made on the living plants. Some time after their being sent off, as Dr Jack informs us, a letter was received from Sir Joseph Banks, acknowledging the receipt of the first specimens, which had all proved to be males, and suggesting the probability of the plant being parasitic, a conjecture which had already been ascertained to be correct, by investigations on the spot. Mr Brown, in the last volume of the Linnean Transactions, has published a classical description of this gigantic flower, accompanied with splendid coloured figures.

54. *Camphor-Tree, Dryobalanops camphora.*—Specimens of this tree in flower (Dr Jack observes) were sent by Mr Prince from Tapanooly to Sir T. S. Raffles in 1819. In Sumatra, the camphor-trees are confined to the country of the Battas, which extends about a degree and a half to the north of the Equator. They are also found in Bornee, in nearly the same parallel of latitude; and Dr Jack thinks there are some in the neighbourhood of Singapore and Johore. This valuable tree, Dr Jack informs us, is not known to exist in any other part of the world, and on this account, as well as the difficulty of obtaining its produce, this kind of camphor bears a very high price. It is all carried to China, where it sells for about twelve times as much as that of Japan. The camphor is found in a concrete state, in cavities and fissures in the heart of the tree. In order to obtain it, the tree is felled and split into lengths, to allow of the extraction of the crystallised masses. The same trees afford both the concrete substance and an oil, which is supposed to be the first stage of the formation of the camphor. The Sumatran camphor is little known in Europe, and it would perhaps, Dr Jack observes, deserve examination, to ascertain how far its pro-

perties differ from those of the common kind. It appears to be less volatile, and its odour is not so diffusive.

55. *Varnish-Tree of Rumphius; Stagmaria verniciflua, of Dr Jack.*—This tree grows to a considerable size, and is met with in the Eastern India Islands, and also in Sumatra. Its wood, Dr Jack says, is of a fine dark colour towards the centre, and the lighter coloured near the circumference. The bark exudes a resin which is extremely acrid, and, applied to the skin, causes excoriations and blisters. The people consider it dangerous to handle any part of the tree, and even to sit or sleep under its shade. This resin, on exposure to the air, soon assumes a black colour, and becomes hard. It is collected and employed as a varnish, and sells for this purpose at a high price. According to Rumphius, it is the tree which yields the so much celebrated Japan lacquer or varnish, and he considers it the same with that of Siam and Tonquin. Loureiro, however, who had better opportunities of observing the latter, represents the varnish of these countries as the produce of a different tree, which he has described under the name Augia. The varnish of Siam of Cochinchina is probably the best; but that of Celebes and Java, which is the produce of this tree, is also employed for the same purposes, and cannot be much inferior, as it bears as high a price.

IV. GENERAL SCIENCE.

56. *On the Dutch Troy Pound.*—"In No. VIII. of your valuable Journal, p. 449., it is stated, that Mr Anderson of Perth demonstrated, that the original weight of the *Dutch* Troy pound had *been* 7680 grains. This drew my attention, as I have been engaged for several years in whatever concerns the subject of weights and measures in this country. I leave it to Mr Anderson to determine what the Dutch Troy pound *has* been, but will venture to give my opinion on what it actually is,—a copy of the standard according to which Troy weight in this country has been adjusted for nearly a century. It was taken to Paris by Messrs Van Swinden and Aeneæ, and there by these gentlemen and M. Lefevre Gineau carefully compared with the kilogramme. This comparison, when accurate kilogrammes were

afterwards brought to this country, has been repeated several times, and the Dutch pound *Troy weight* was found equal to 492,16772 grammes. Now, supposing that one grain *English* Troy is equal to 0,0647508 grammes, we have

Log 492,16772 = 2.6921131
Log 0,0647508 = 8.8112453

3,8808678 Number is 7600,95
50
25

Therefore, I conclude, that the Dutch Troy weight, as actually in use in this country, is 7600,95 English Troy grains, which leaves a difference of 79 grains in the pound with Mr Anderson's statement. The standard of the Dutch Troy weight, which was in use in 1553, in the reign of Charles V., is still preserved, and it may be shewn that this standard underwent no alteration since that time. This old standard is somewhat lighter than that which is used now, the difference being about 288 milli-grammes in the pound of Dutch Troy weight."—*Letter from Professor Moll of Utrecht.*

57. *Detonations in Mount Brasier.*—M. Dubois Aymé examined, in 1818, the structure of the mountain (situated between Senes and Larógne in the Alps) which is known to emit flame, and to produce detonations, which are most frequent when the wind is in one direction. He found that there were beds of pyritous-chalk, marly schists, radiated sulphuret of iron, and bituminous substances, &c. in the strata of limestone that formed its sides, and he supposes that the flames and detonations are produced by the accidental inflammation of hydrogen liberated by the action of water on the above substances.

58. *Method of rendering Cloth incombustible.*—M. Gay Lussac has found, that the most effectual solutions for rendering cloths incombustible, are *solutions of muriate, sulphate, phosphate and borate of ammonia*, with *borax*, and also some mixtures of these salts. M. Merat Guillot of Auxerres has shewn, that the acidulous phosphate of lime possesses the same property. When linen, muslin, wood, or paper, are dipped in a solution of that salt, of the specific gravity of from 1.26 to 1.30, they become completely incombustible. They may be charred by an intense heat, but they will not burn.

59. *Eggs preserved 300 years.*—In the wall of a chapel near the Lago Maggiore, built more than 300 years ago, three eggs, imbedded in the mortar of the wall, were found to be quite fresh. It has long been known that bird's eggs brought from America or India, covered with a film of wax, have been hatched in Europe after the wax had been dissolved by alcohol.

60. *Fatal Accident from the fumes of Iron Cement.*—In November last, a smith at Maidstone, was repairing the inside of the boiler of a steam-engine, and in joining two pieces of iron, he made use of a cement composed of sal-ammoniac, sulphur, and iron-turnings, which produced such a quantity of fumes, that he was suffocated in a few moments. His assistant being at work on the outside, and hearing a struggling noise within, got through the opening at the top of the boiler, and while descending to his master's assistance, inhaled the fumes, and fell to the bottom. A workman attempted twice to descend to his assistance, but he was so powerfully affected by the effluvia, that he was obliged to desist. A large quantity of water having been thrown into the boiler, the bodies were brought out. The master was quite dead; and his assistant, though he exhibited some appearance of life when taken out, died next morning.—*Technical Repository*, No. I. p. 77.

61. *Volcano in the Island of Banda.*—An eruption from the Volcano in the Island of Banda took place on the 11th June 1820. It commenced with a thick volume of smoke, accompanied with a dreadful noise like thunder, and then ejected stones with great force and noise. At night the spectacle became truly awful, and it appeared like a pile of fire. Earthquakes, and thunder and lightning were so frequent, that the inhabitants fled in all directions. After fourteen days the eruption subsided, and the inhabitants returned to their homes, although flame and much smoke are still discharged from the mountain.

62. *Earthquake at Celebes.*—On the 29th of December 1820, a destructive earthquake took place on the south coast of the Island of Celebes. At Boelækomba, where it did great damage, the sea rose several times to a prodigious height, and then quickly falling again, it thus alternately deluged and left the coast. All the plantations from Bontain to Boelækomba were

destroyed, the forts at these places were much injured, and many hundred persons lost their lives.

Art. XXIX.—*List of Patents granted in Scotland from 17th November* 1821 *to 5th February* 1822.

22. To David Gordon of the city of Edinburgh, at present residing at Stranraer, Esq.—For "certain improvements in the construction of wheel-carriages." Sealed at Edinburgh the 28th December 1821.

1. To Henry Robertson Palmer of the Salopian Coffee-house, Charing Cross, county of Middlesex, Civil-Engineer:—For an "improvement or improvements in the construction of railways or tram-roads, and other carriages to be used thereon." Sealed at Edinburgh the 7th January 1822.

2. To John Gladstone, Engineer and mill-wright, Castle Douglas, in the Stewartry of Kirkcudbright, and Shire of Galloway, North Britain:—For an "improvement in the construction of steam-vessels, and mode of propelling such vessels by the application of steam or other power." Sealed at Edinburgh the 1st February 1822.

3. To Richard Summers Harford of Elbro Vale Iron-Works, parish of Abenystruth, county of Monmouth, one of the people called Quakers:—For an "improvement in that department of the manufacture of iron, commonly called Puddling." Sealed at Edinburgh the 1st February 1822.

4. To Dominique Pierie Deurbrancy of Frith Street, Soho, county of Middlesex, gentleman,—For an "apparatus for the purpose of condensing the alcoholic steams arising from spiritous liquors, such as wine, brandy, beer, cyder, and other spiritous liquors, during their fermentation." Sealed at Edinburgh the 1st February 1822.

5. To Stephen Wilson of Streatham, county of Surrey, Esq.:—For "certain improvements in machinery for weaving figured goods. Sealed at Edinburgh the 1st February 1822.

6. To Charles Broderip of London, Esq. residing in Glasgow,—For "various improvements in the construction of steam-engines." Sealed at Edinburgh the 5th February 1822.

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